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MONTHLY SUMMARY OF

SPACE

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ACTIVITIES

EXEMPTED FROM DECLASSIFICATION IAW E.O. 12958

REVIEWED BY Sb

DATE 4 Jun 98

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EXEMPTIONS 1 2 3 4 5 6 7 8 9

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MARCH 1961

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WDLPR-4-281

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a foreword to...

SPACE

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HEADQUARTERS
SPACE SYSTEMS DIVISION
AIR FORCE SYSTEMS COMMAND
UNITED STATES AIR FORCE
Air Force Unit Post Office, Los Angeles 45, California

WDLPR-4

14 April 1961

Monthly Summary of SPACE SYSTEM DIVISION Activities

MARCH 1961

FOREWORD

Two space vehicles were launched during March. DISCOVERER XXII did not reach sufficient velocity to attain orbit because of a hydraulic system malfunction in the AGENA stage. BLUE SCOUT missile D-4 successfully boosted a 172-pound Air Force Special Weapons Center payload to an altitude of approximately 1,380 nautical miles on a probe trajectory. All test objectives were achieved and valuable radiation measurement information was obtained by the six payload experiments. This month's report also includes extensive additional information in the program description portion of the Project MERCURY Section and the Space Program Boosters Section.

Henry B. Kucheman Jr.

for O. J. RITLAND
Major General, USAF
Commander

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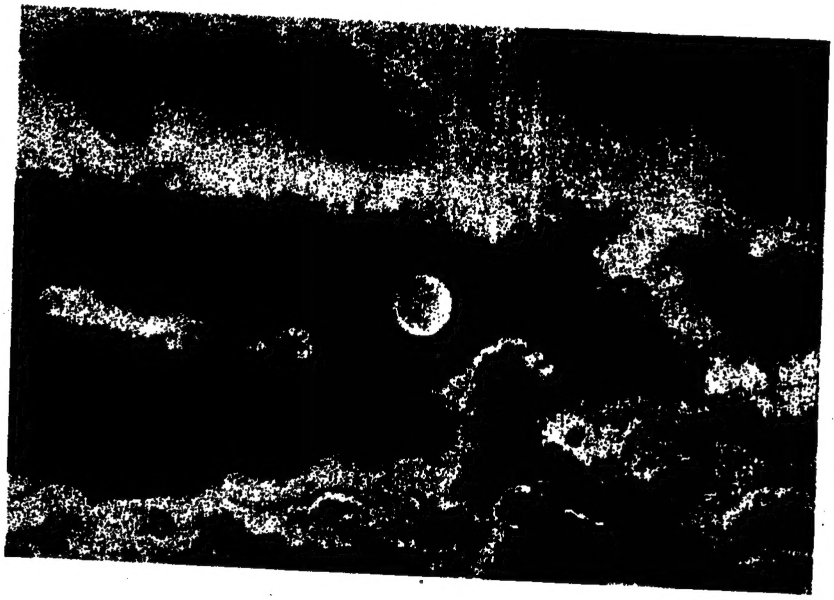
SATELLITE

systems



DISCOVERER
MIDAS
ADVENT

Discoverer

The DISCOVERER Program consists of the design, development and flight testing of 39 two-stage vehicles, using the Douglas DM-21 Space Booster as the first stage booster and the AGENA as the second stage, satellite vehicle. The program was established early in 1958 under direction of the Advanced Research Projects Agency, with technical management assigned to AFBMD. On 14 November 1959, program responsibility was transferred from ARPA to the Air Force by the Secretary of Defense. Prime contractor for the program is Lockheed Missile and Space Division. The DISCOVERER Program will perform space research in support of the advanced military reconnaissance satellite programs.

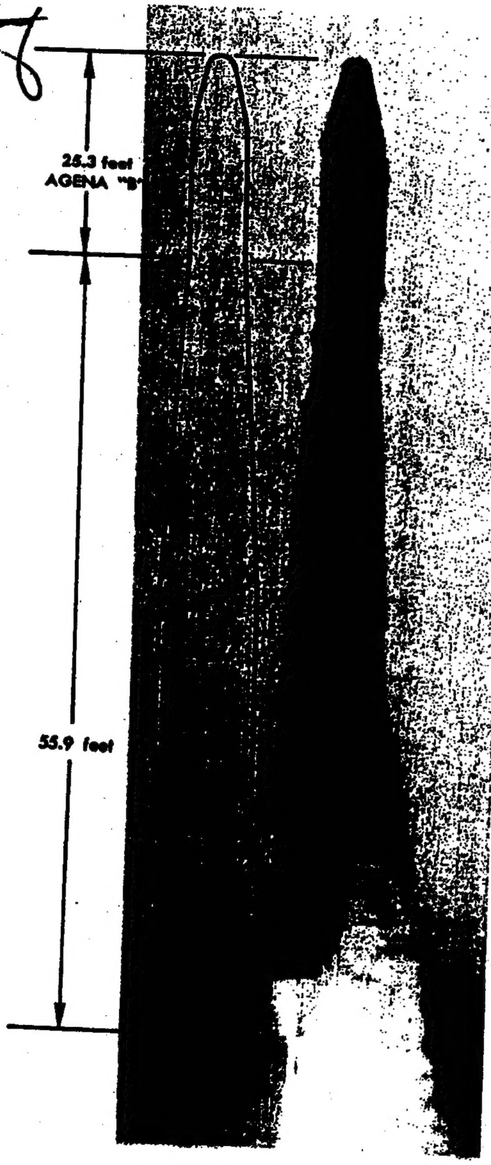
PROGRAM OBJECTIVES

- (a) Flight test of the satellite vehicle airframe, propulsion, guidance and control systems, auxiliary power supply, and telemetry, tracking and command equipment.
- (b) Attaining satellite stabilization in orbit.
- (c) Obtaining satellite internal thermal environment data.
- (d) Testing of techniques for recovery of a capsule ejected from the orbiting satellite.
- (e) Testing of ground support equipment and development of personnel proficiency.
- (f) Conducting bio-medical experiments with mice and small primates, including injection into orbit, re-entry and recovery.

PROGRAM SUMMARY

Early launches confirmed vehicle flight and satellite orbit capabilities, developed system reliability, and established ground support, tracking and data acquisition requirements. Later in the program, biomedical and advanced engineering payloads will be flight tested to obtain support data for more advanced space systems programs. DISCOVERER vehicles are launched from Vandenberg Air Force Base, with overall operational control exercised by the Satellite Test Center, Sunnyvale, California

Tracking and command functions are performed by the stations listed in the Table on Page A-4. A history of DISCOVERER flights to date is given on pages A-5 and A-6.



SECOND STAGE	AGENA "B"
Weight—	
Inert	1,346
Payload equipment	915
Orbital	2,261
Impulse propellants	12,950
Other	511
TOTAL WEIGHT	15,722
Engine Model	XLR81-Ba-9
Thrust-lbs., vac.	16,000
Spec. Imp.-sec., vac.	290
Burn time-sec.	240
BOOSTER	DM-21
Weight—Dry	6,500
Fuel	33,700
Oxidizer (LOX)	68,200
GROSS WEIGHT (lbs.)	108,400
Engine	MB-3 Block 2
Thrust, lbs. (S.L.)	169,000
Spec. Imp., sec. (S.L.)	248.3
Burn Time, sec.	148

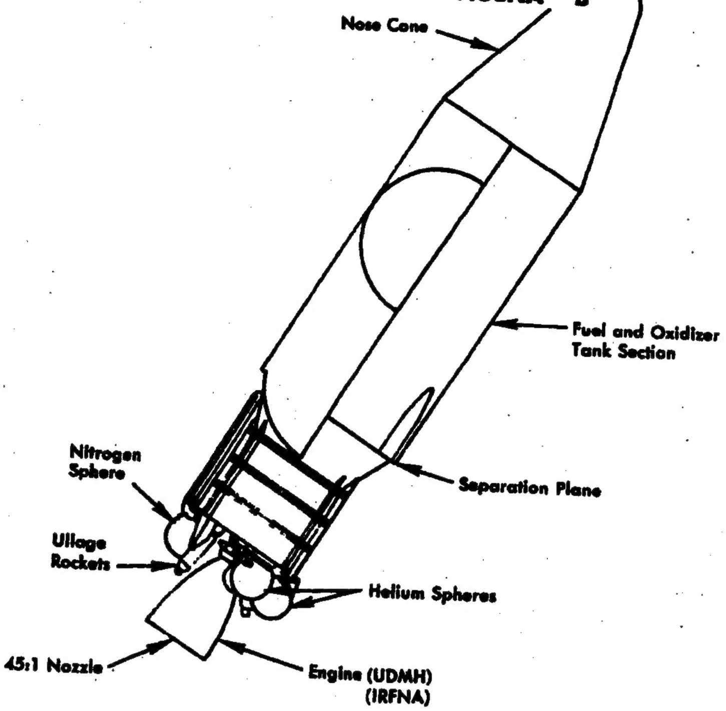
Telemetry ships are positioned as required by the specific mission of each flight. Illustrations on the opposite page show a typical launch trajectory from Vandenberg Air Force Base and a typical orbit. An additional objective of this program is the development of a controlled re-entry and recovery capability for the payload capsule. The recovery operation is also shown on the opposite page. An impact area has been established near the Hawaiian Islands and a recovery force activated. Techniques have been developed for aerial recovery by C-119 and JC-130 aircraft and for sea recovery by Navy surface vessels. The recovery phase of the program has provided advances in re-entry technology. This information will be used in support of more advanced projects, including the return of a manned satellite from orbit.

AGENA VEHICLE DEVELOPMENT

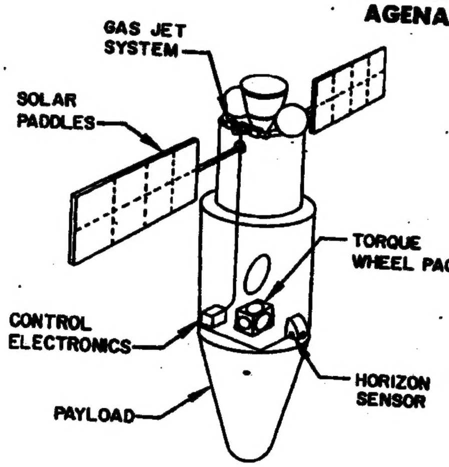
The AGENA vehicle was originally designed by the Air Force as the basic satellite vehicle for Advanced Military Reconnaissance Satellite Systems Programs. The first AGENA satellites or "A" configuration employed the YLR-81Ba-5 engine which developed 15,600 pounds thrust at altitude. The development of an optical inertial system for vehicle stabilization and an attitude control system for orbit injection resulted from the advanced programs stringent eccentricity requirements.

By increasing the tank capacities on the AGENA "A" an improved performance capability was achieved. This new configuration or AGENA "B" used the bell XLR-81Ba-7 engine and was first flown on DISCOVERER XVI. The latest AGENA "B" vehicles use the 16,000 pound thrust XLR-81Ba-9 engine which has a restart capability. This larger vehicle permits achieving higher injection altitudes with equivalent weight payloads and the restart provision permits orbital adjustment.

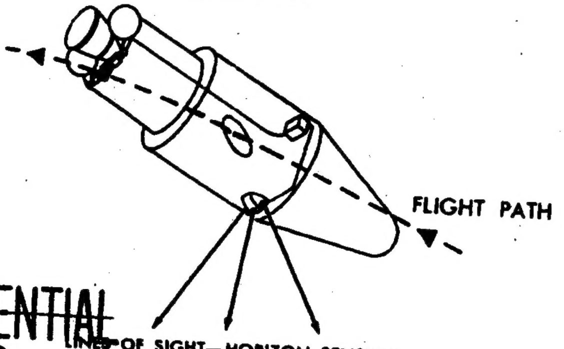
AGENA "B"



SAMOS and MIDAS AGENA VEHICLE

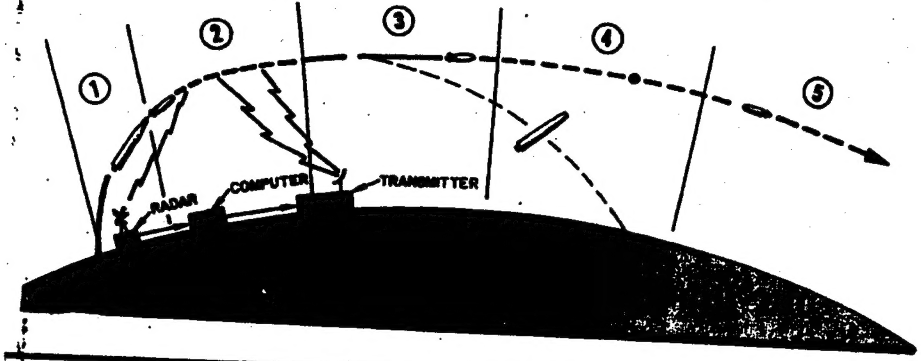


DISCOVERER/AGENA

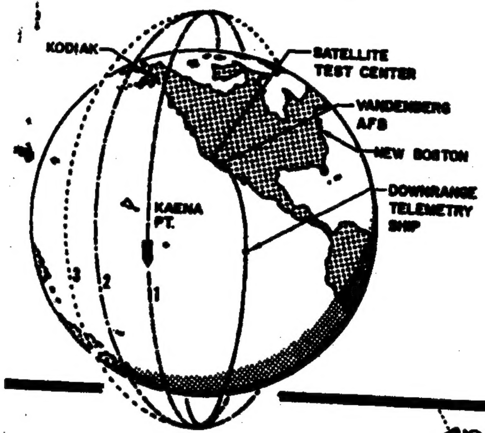


LINES OF SIGHT—HORIZON SENSING

Powered Flight Trajectory



1. **First Stage Powered Flight** — 2.5 minutes duration, 78 n.m. downrange, guided by programmed autopilot and BTL guidance.
2. **Coast Period** — 2.4 minutes duration, to 380 n.m. downrange, attitude controlled by inertial reference package, horizon scanner, gas reaction jets. Receives AGENA time to fire and velocity to be gained commands.
3. **Second Stage Powered Flight** — Approximately four minutes or until injection velocity is attained. Pitch and yaw stabilization achieved by gimballing the engine and roll by gas reaction jets. Engine shutdown achieved by integrator accelerometer cutoff command.
4. **Vehicle Reorients to Nose Aft** — 2 minutes duration. Guided and attitude controlled by inertial reference package, horizon scanner and gas reaction jets.
5. **In Orbit** — Controlled (same as 4).

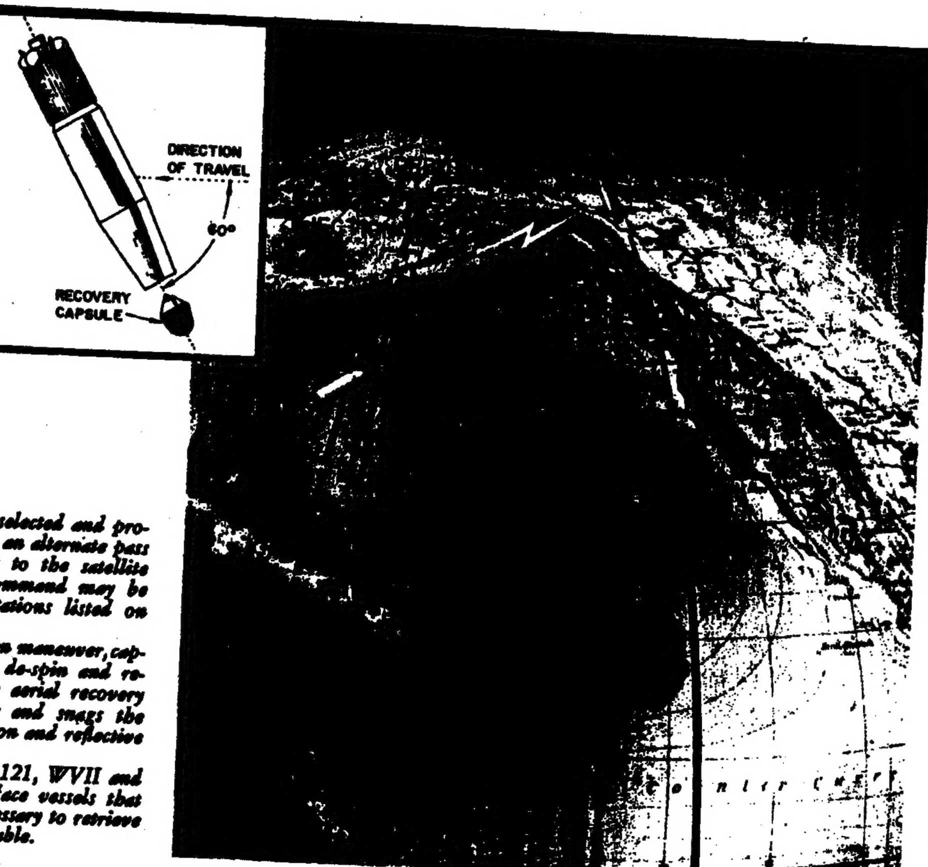


Orbital Trajectory

Schematic presentation of orbital trajectory following launch from Vandenberg Air Force Base. Functions performed by each station and a listing of equipment used by each station, is given on page 4.

RECOVERY CAPABILITY

This objective was added to the program after the first launch achieved vehicle flight and orbit objectives successfully. It includes the orientation of the satellite vehicle to permit a recoverable capsule to be ejected from the nose section of the AGENA vehicle. Ejection is programmed to occur on a selected orbit, for capsule impact within the predetermined recovery area near Hawaii. Aircraft and surface vessels are deployed within the area as a recovery force.



CAPSULE RECOVERY SEQUENCE

- *The desired orbit for capsule ejection is selected and programmed into the vehicle prior to launch. If an alternate pass is desirable, an ejection command is sent to the satellite before this alternate re-entry pass. This command may be sent from any of the primary tracking stations listed on page A-4.*
- *The ejection sequence includes a pitch down maneuver, capsule separation, spin-up, retro-rocket firing, de-spin and re-entry. Following parachute deployment the aerial recovery force converges on the descending capsule and snags the parachute. The capsule contains a radio beacon and reflective chaff which is dispersed to aid in tracking.*
- *The recovery force consists of C-119, RC-121, WVII and JC-54 aircraft supplemented by 2 or 3 surface vessels that receive and record telemetry data. If it is necessary to retrieve the capsule from the sea, these ships are available.*

Facility	Equipment*	Flight Function
Satellite Test Center	ABCD	Over-all control, orbit computations and predictions, acquisition data for tracking stations, prediction of recovery area.
†Vandenberg AFB Tracking Station	BDEFGHIJ	Ascent and orbital tracking, telemetry reception, trajectory measurements, command transmission.
†Mugu Tracking Station	BDEFGHIJ	Ascent tracking, telemetry reception, computation and transmission of ignition and shutdown corrections.
Downrange Telemetry Ship	BGIJK	Telemetry reception and tracking during ascent and early part of first orbit.
†New Hampshire Tracking Station	BDFGHIJ	Orbit tracking, telemetry reception, commands to satellite.
†Kodiak Tracking Station	BDFGHIJ	Orbit tracking, telemetry reception, initial acquisition on pass 1, monitor events in recovery sequence.
†Hawaiian Tracking Station	BDFGHIJ	Orbit tracking, telemetry reception and transmission of commands to satellite.
Hickam AFB Oahu, Hawaii	D	Over-all direction of capsule recovery operations.
Tern island	BGHJ	Recovery capsule tracking.

†Primary Tracking Stations (have command capability)

***Equipment**

A. General Purpose Computer(s) and Support Equipment
B. Data Conversion Equipment
C. Master Timing Equipment
D. Control and Display Equipment
E. Guidance and Command Equipment (DISCOVERER ascent only)
F. VERLORT
G. VHF FM/FM Telemetry Station
H. VHF Direction Finding Equipment
I. Doppler Equipment
J. VHF Telemetry Antenna
K. APL Doppler Equipment

NOTE: In addition to equipment listed, all stations have inter- and intra-station communications equipment and checkout equipment.

Launch Schedule

A	●	J	1959
	★	F	
		M	
	★	A	
		M	
	● ●	J	
		J	
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		S	
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C		J	1961
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	●	M	
	1	A	
	1	M	
	2	J	
	3	J	
	2	A	
	1	S	
	3	O	
	2	N	
	1	D	

★ Attained orbit successfully.

® Capsule recovered.

● Failed to attain orbit.

Flight History

DISCOVERER No.	THOR No.	AGENA No.	Flight Date	Remarks

DISCOVERER FLIGHTS 0 THRU XX ARE ON PAGE A-6

DISCOVERER No.	THOR No.	AGENA No.	Flight Date	Remarks
XXI	261	1102	18 February	*Attained orbit successfully. Non-recoverable, radiometric data gathering MIDAS support flight.*
XXII	300	1105	30 March	*Launch, ascent, separation, coast and orbital stage ignition normal. Orbital velocity was not attained because of an AGENA hydraulic malfunction.*

VEHICLE CONFIGURATIONS

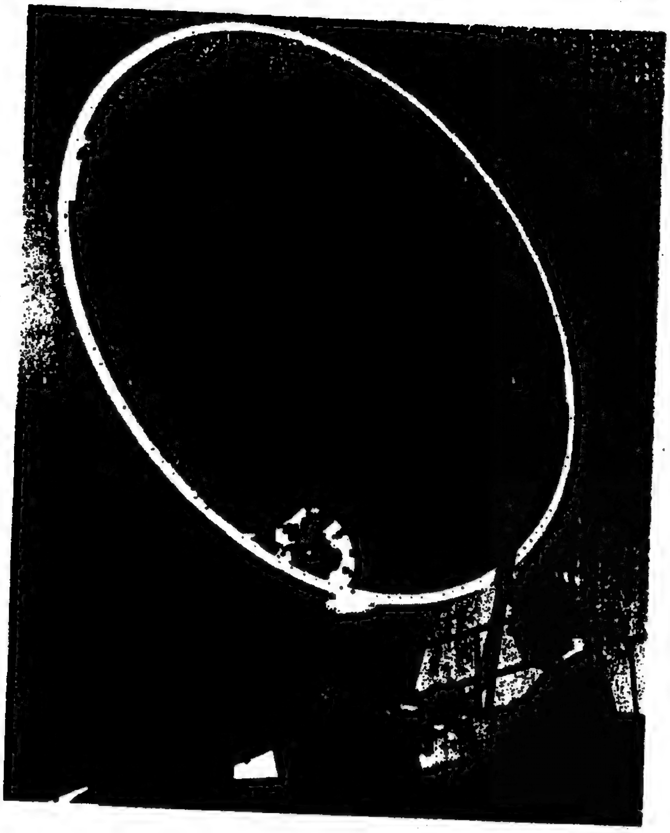
A. THOR—DM-18/AGENA "A"

B. THOR—DM-21/AGENA "B"
MB-3 Block 1/XLR81-Ba-7

C. THOR—DM-21/AGENA "B"
MB-3 Block 2/XLR81-Ba-9

Flight History (continued)

DISCOVERER No.	THOR No.	AGENA No.	Flight Date	Remarks
0	160	1019	21 January 1959	*AGENA destroyed by malfunction on pad. THOR refurbished for use on flight XII.*
I	163	1022	28 February	*Attained orbit successfully. Telemetry received for 514 seconds after lift-off.*
II	170	1018	13 April	*Attained orbit successfully. Recovery capsule ejected on 17th orbit was not recovered. All objectives except recovery successfully achieved.*
III	174	1020	3 June	*Launch, ascent, separation, coast and orbital boost successful. Failed to achieve orbit because of low performance of satellite engine.*
IV	179	1023	25 June	*Same as DISCOVERER III.*
V	192	1029	13 August	*All objectives successfully achieved except capsule recovery after ejection on 17th orbit.*
VI	200	1028	19 August	*Same as DISCOVERER V.*
VII	206	1051	7 November	*Attained orbit successfully. Lack of 400-cycle power prevented stabilization on orbit and recovery.*
VIII	212	1050	20 November	*Attained orbit successfully. Malfunction prevented AGENA engine shutdown at desired orbital velocity. Recovery capsule ejected but not recovered.*
IX	218	1052	4 February 1960	*THOR shut down prematurely. Umbilical cord mast did not retract. Quick disconnect failed, causing loss of helium pressure.*
X	223	1054	19 February	*THOR destroyed at T plus 56 sec. by Range Safety Officer. Severe pitch oscillations caused by booster autopilot malfunction.*
XI	234	1055	15 April	*Attained orbit successfully. Recovery capsule ejected on 17th orbit was not recovered. All objectives except recovery successfully achieved.*
XII	160	1053	29 June	*Launch, ascent, separation, coast and orbital stage ignition were successful. Failed to achieve orbit because of AGENA attitude during orbital stage boost.*
XIII	231	1057	10 August	*Attained orbit successfully. Recovery capsule ejected on 17th orbit. Capsule was recovered after a water impact with negligible damage. All objectives except the airborne recovery were successfully achieved.*
XIV	237	1056	18 August	*Attained orbit successfully. Recovery capsule ejected on 17th orbit and was successfully recovered by the airborne force. All objectives successfully achieved.*
XV	246	1058	13 September	*Attained orbit successfully. Ejection and recovery sequence completed. Capsule impact occurred south of the recovery forces; located but lost prior to being retrieved.*
XVI	253	1061	26 October	*Launch and ascent normal. AGENA failed to separate from booster and failed to attain orbit.*
XVII	297	1062	12 November	*Attained orbit successfully. Recovery capsule ejected on 31st orbit and aerial recovery was accomplished. All objectives were successfully achieved.*
XVIII	296	1103	7 December	*Attained orbit successfully. Recovery capsule ejected on 48th orbit and aerial recovery was accomplished. All objectives were successfully achieved.*
XIX	258	1101	20 December	*Attained orbit successfully. Non-recoverable, radiometric data gathering MIDAS support flight.*
XX	298	1104	17 February	*Attained orbit successfully. Capsule did not re-enter due to on-orbit malfunction.*



Monthly Progress — DISCOVERER Program

Flight Test Progress

DISCOVERER XXII

- DISCOVERER XXII was launched from Vandenberg Air Force Base Pad 4 Complex 75-3 at 12:34 PST on 30 March. Recovery of the vehicle's capsule was scheduled after four days on orbit. Booster operation was nominal. The 20 cycles per second longitudinal oscillation appeared as on previous flights but on a slightly lower level. AGENA ignition occurred as planned; however, approximately 20 seconds prior to engine shut down a rapid drop in hydraulic pressure caused a loss of engine control. This resulted in a total velocity less than that required to attain orbit. Investigation into the cause of the hydraulic failure is proceeding rapidly so that corrective action can be taken prior to the scheduled launch of DISCOVERER XXIII.
- The Bell Telephone Laboratory (BTL) guidance system was used to guide the DM-21 booster for the first time. This system also commands AGENA ignition, vehicle correction and operation. Preliminary results indicate that the BTL guidance performance was excellent.

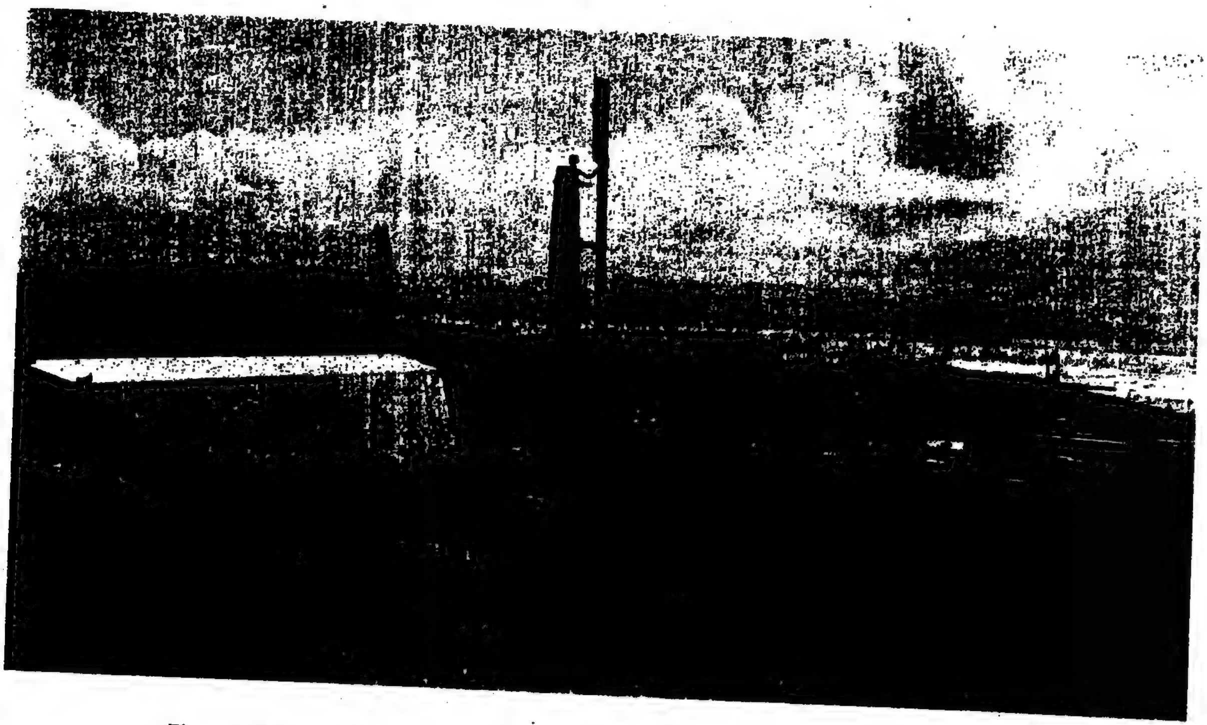


Figure 1. Booster for DISCOVERER XXIII on Pad 4, Complex 75-3 at Vandenberg Air Force Base. The vehicle was launched on 30 March, but did not attain orbit. Modification of this launch pad started immediately after the launch. BTL guidance system components (top left). The upper container houses the flight controller and the large unit is the inertial reference package.

- The recovery capsule containing a Biopack and a Geophysical Research Directorate emulsion block for further studies into effects of space radiation on biomedical experiments. These were similar to the Biopack and emulsion blocks carried on several previous DISCOVERER flights.

- Several important modifications were made on this satellite. Instrumentation was added to the interim programmer to permit tracking stations to better determine the conditions of the programmer before sending commands. This was done to preclude a recurrence of the malfunction that resulted in the failure to eject the capsule on DISCOVERER XX.

- A different model single phase, 400-cycle power amplifier was installed in DISCOVERER XXII to increase the reliability of this satellite guidance system power supply. The loss of satellite stability on DISCOVERER XXI was attributed to a failure of the previous amplifier.

Future Flights

- DISCOVERER XXIII is scheduled for launch on 8 April from Vandenberg Air Force Base. This satellite is almost identical to DISCOVERER XXII but is programmed for slightly different orbit. The injection altitude will be 190 statute miles which is 40 miles higher than DISCOVERER XXII. A dosimeter capable of measuring total dosimeter radiation (5 millirad to 600 rad range) will be included in the payload.

- DISCOVERER XXIII, XXIV, and XXV will be instrumented to provide data on the 20 cycle per second longitudinal oscillation. This oscillation has been apparent immediately prior to booster burnout on several recent DISCOVERER flights. Data indicate that the oscillations are induced by the MB3 rocket engine and the reduction or elimination of the oscillator is being pursued by an analysis and test program conducted by Rocketdyne, Douglas Aircraft and Lockheed Missile and Space Division. Instrumentation added to these vehicles will provide data indicating the distribution of loads imposed by the oscillation. This data could serve as a basis for strengthening the spacecraft in areas where the loads approach the design limits.

Technical Progress

Second Stage Vehicle

- The Engine Reliability test program is nearing completion at the Bell Aerosystems test facilities.

Figure 2. The new engine access door which provides mounting space for research instruments. The instruments on the door are from the Geophysical Research Directorate and include a cosmic ray monitor, micrometeorite detector and two density gauges. The white cone on the right is a heat shield which is installed to protect vehicle components from flame damage in space. The pencil-like flame characteristic of rocket engines in the atmosphere becomes a large ball which envelops the engine in space.

Thirty-seven of the 40 firings scheduled have been completed. These tests are now scheduled for completion in mid-April.

- Twenty-three of the 25 Arnold Engineering Development Center reliability test firings have been completed.

Space Research Program

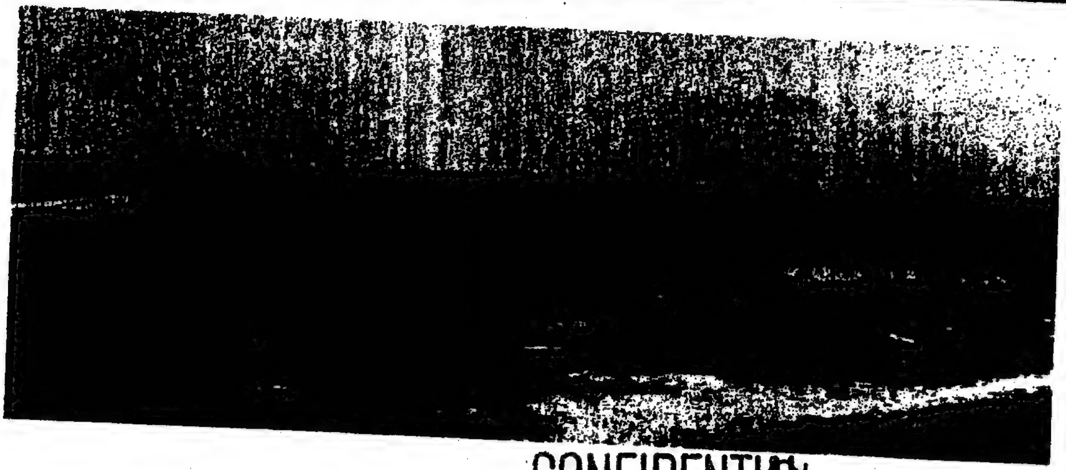
- Programs utilizing the increased DISCOVERER weight carrying capability for scientific experiments in the space environment are being greatly expanded. The success of earlier experiments (flashing lights, Biopacks and Geophysical Research Directorate equipment) indicates a major contribution to scientific knowledge can be made by carrying this type of equipment. About half of the remaining DISCOVERER satellites to be flown will each be capable of carrying approximately 100 pounds of scientific instruments and recorders.

- To facilitate the installation of this equipment, a new access door to the engine compartment has been designed and fabricated. The new door is designed with universal type mounting rails on the under side for mounting components. The Geophysical Research Directorate module is pre-wired to permit installation in the satellite with a minimum delay of prelaunch operations. Starting in June, each satellite will have the capability of carrying such modules.

Geophysical Research Directorate (GRD) Experiments

The Geophysical Research Directorate is furnishing equipment for a number of DISCOVERER flights aimed primarily at determining environment in space:

Figure 3. First photographs of the DISCOVERER Christmas Island facilities. This tracking station is manned only during DISCOVERER flights. The station is located south of Hawaii near the equator and tracks the capsule during re-entry.



1. Atmospheric Density: This will include measurements of atmospheric density and determination of the existence of atmospheric waves at altitudes of 100 to 400 miles as a function of latitude, time of day and season. Calculations based on these data will be valuable in determining vehicle drag and lifetime.

2. Cosmic Radiation. These measurements will be made to assess the radiation hazard to components above 130 miles, in the Van Allen and Auroral regions.

3. Thermal Radiation. Infrared radiation from the earth and atmosphere, scattered solar radiation will be measured to obtain data for calculating proper vehicle equilibrium temperatures.

4. Micrometeorites. Rates of penetration of vehicle skin, mass, density and energy of micrometeorites, and skin erosion will be measured to obtain data on thermodynamic effects.

5. Solar Ultraviolet Radiation. Solar radiation in the ultraviolet and X-ray regions will be measured to determine aging effects on plastic and organic materials.

6. Atmospheric Composition. Data on the kinds and states of atmospheric particles, since organic and plastic materials show aging, corroding or chemical effects when exposed to free radicals such as atomic oxygen. Data on ion concentrations are needed.

7. Magnetic Field. Results from more complete studies of the earth's magnetic field are of interest for possible use in attitude stabilization systems. Magnitude and direction at various altitudes will be determined. Long term variations will also be determined.

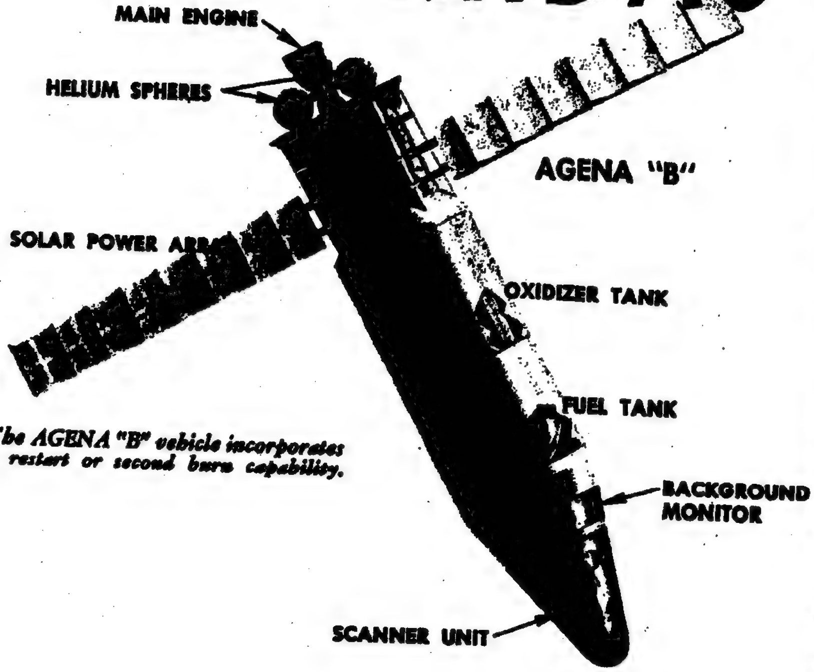
Facilities

- Pad 1 of Complex 75-1 is currently being modified and will be activated in time to support a late May DISCOVERER launch. This pad is being converted from a THOR/IRBM to a DISCOVERER launch facility. Modifications required include extending the missile shelter to accommodate the DM-21/AGENA combination, adding the DISCOVERER fuel transfer, ground support and launch control systems. Because of delinquencies in delivering the launch control system equipment, activation of the pad is approximately thirty days behind schedule.

- Rework of Complex 75-3 Pad 4 began immediately after the launch of DISCOVERER XXII. A new propellant transfer system and launch control system equipment are required as part of this modification. This pad is scheduled to support an early June DISCOVERER launch. A similar rework of Pad 5 will begin after the launch of DISCOVERER XXIII on 8 April. This pad will be available to support a mid-June launch.

MIDAS

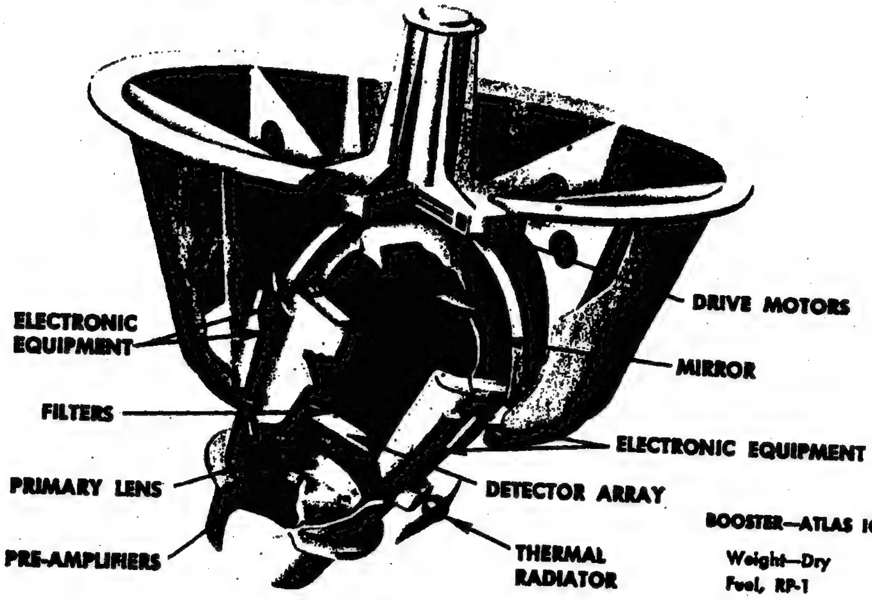
SECOND STAGE	AGENA "B"
Weight—	
Inert	1,763
Payload equipment	1,641
Orbital	3,404
Impulse Propellants	12,950
Fuel (UDMH)	
Oxidizer (IRFNA)	
Other	758
GROSS WEIGHT (lbs.)	17,112
Engine	XLR81-Ba-9
Thrust, lbs. (vac.)	16,000
Spec. Imp., sec. (vac.)	290
Burn Time, sec.	240
Restart Provisions	Yes



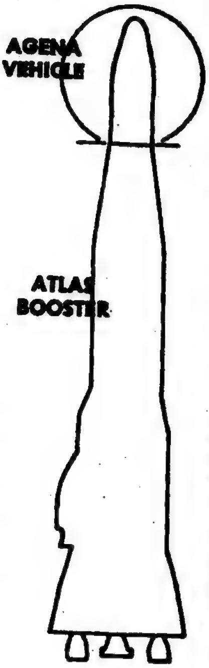
The AGENA "B" vehicle incorporates a restart or second burn capability.

MIDAS Infrared Detection Payload

Payload Operation: Incident radiation passes through the primary lens, then is reflected by the mirror which brings the energy into sharp focus on the detector array. The filter is located in front of the detector array to exclude unwanted radiation. Preamplifiers are mounted in back of the detectors.



BOOSTER—ATLAS ICBM		
Weight—Dry		15,100
Fuel, RP-1		74,900
Oxidizer (LOX)		172,300
GROSS WEIGHT (lbs.)		262,300
Engine—MA-2		
Thrust (lbs. vac.)	Boost	356,000
	Sustainer	82,100
Spec. Imp. (sec. vac.)	Boost	286
	Sustainer	310



PROGRAM HISTORY

The MIDAS Program was included in Weapon System 117L when WS 117L was transferred to the Advanced Research Projects Agency. ARPA subsequently separated WS 117L into the DISCOVERER, SAMOS and MIDAS Programs, with the MIDAS objectives based on an infrared early warning system. The MIDAS (Missile Defense Alarm System) Program was directed by ARPA Order No. 38, dated 5 November 1958 until transferred to the Air Force on 17 November 1959. Additional authorization has been obtained to utilize two DISCOVERER flights (designated RM-1 and RM-2) to carry background radiometers in support of MIDAS.

TECHNICAL HISTORY

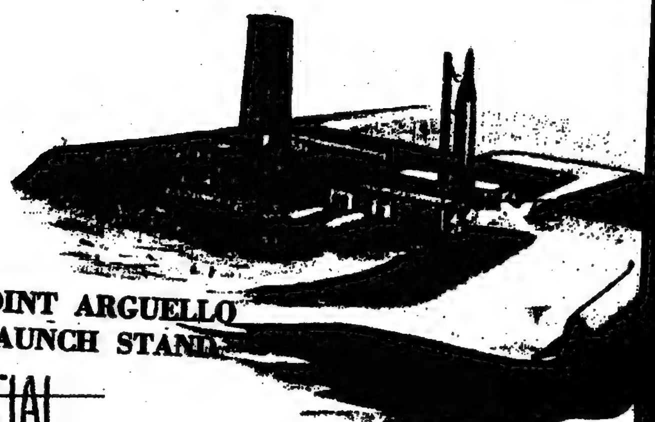
The MIDAS infrared early warning payload is engineered to use a standard launch vehicle configuration. This consists of an ATLAS missile as the first stage and the AGENA vehicle, powered by a Bell Aircraft rocket engine as the second, orbiting stage. The final configuration payload weight will be approximately 1,000 pounds..

The first two R&D flights used the AGENA "A" and ATLAS "D" vehicle programmed to place the payload in a circular 261 nautical mile orbit. Subsequent R&D flights will utilize the ATLAS "D"/AGENA "B" configuration which will be programmed to place the payload in a circular 2,000 nautical mile polar orbit.

OPERATIONS CENTER

Orbiting satellites detect infrared radiation emitted by Soviet ICBM's in powered flight. Data is telemetered instantaneously to Midas Control Center via far north Readout Stations. Decoded data reveal approximately the number of missiles launched and launch location, direction of travel and burning characteristics. This data is graphically displayed on the control consoles and operational displays at the Operations Center. The Tracking and Control Center monitors the whole tracking operation. The Point Arguello stands are used to launch the MIDAS satellites into polar orbits.

TRACKING AND CONTROL C



**POINT ARGUELLO
LAUNCH STAND**

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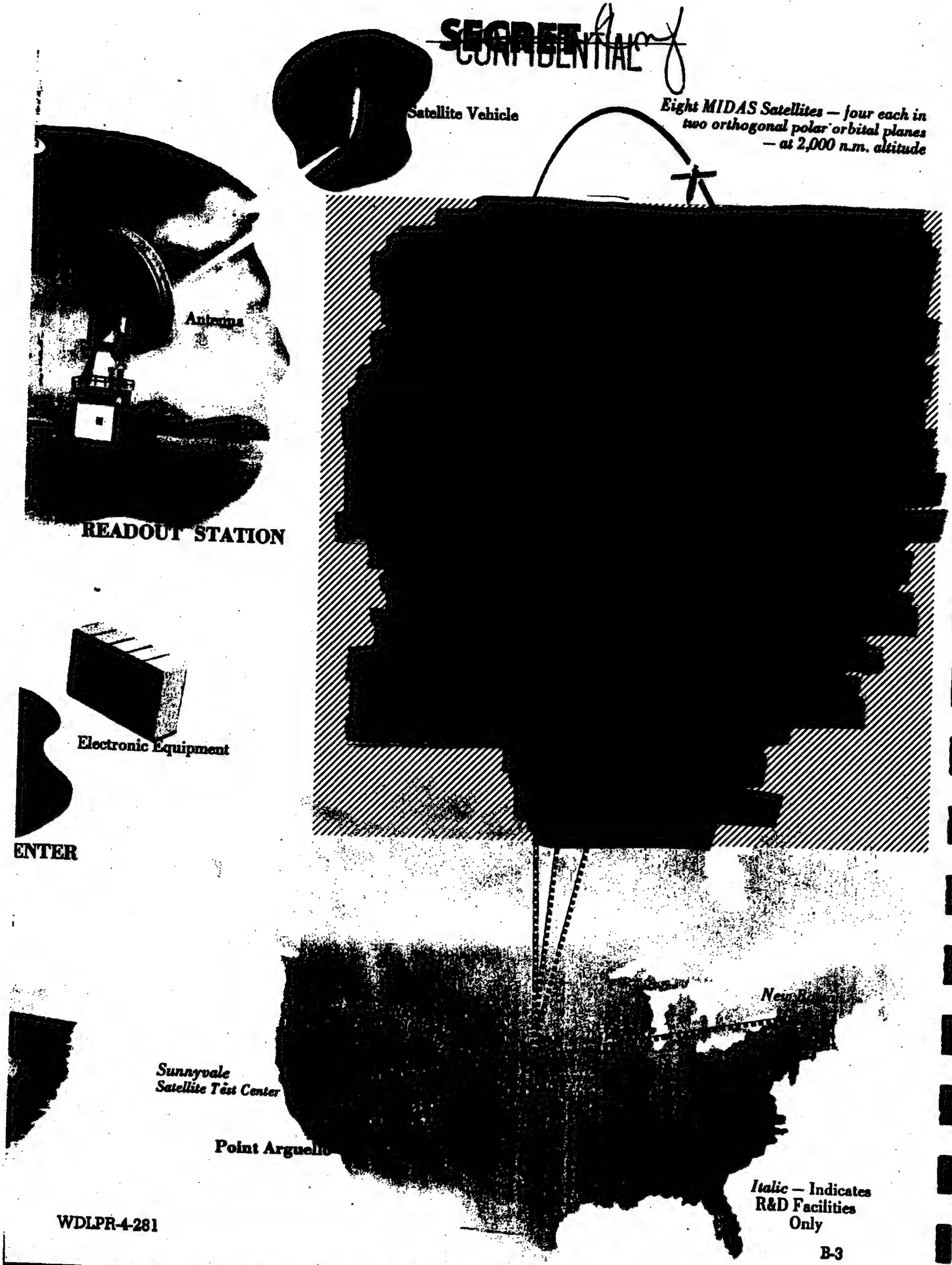
Satellite Vehicle
Eight MIDAS Satellites — four each in two orthogonal polar orbital planes — at 2,000 n.m. altitude
Antenna
READOUT STATION
Electronic Equipment
ENTER
New B
Sunnyvale Satellite Test Center
Point Arguello
Italic — Indicates R&D Facilities Only

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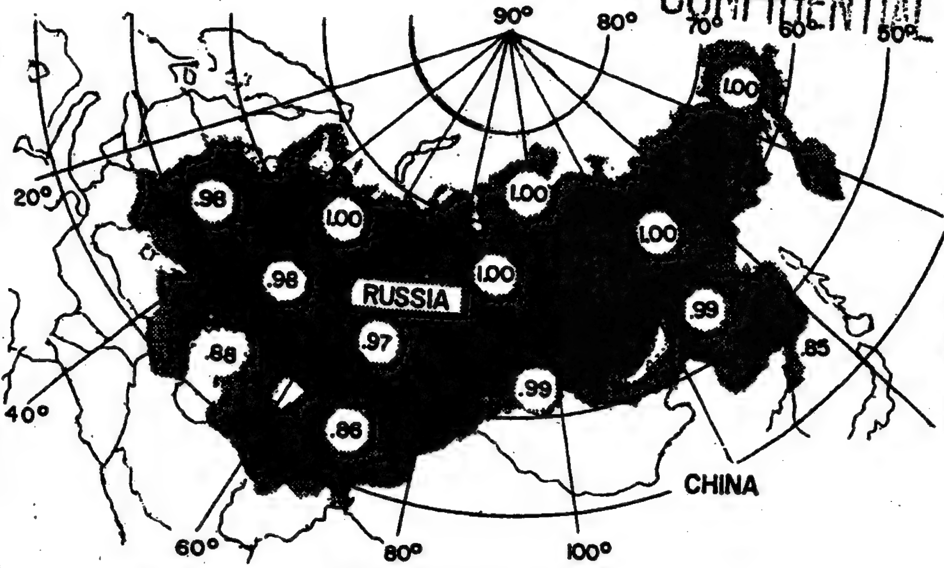
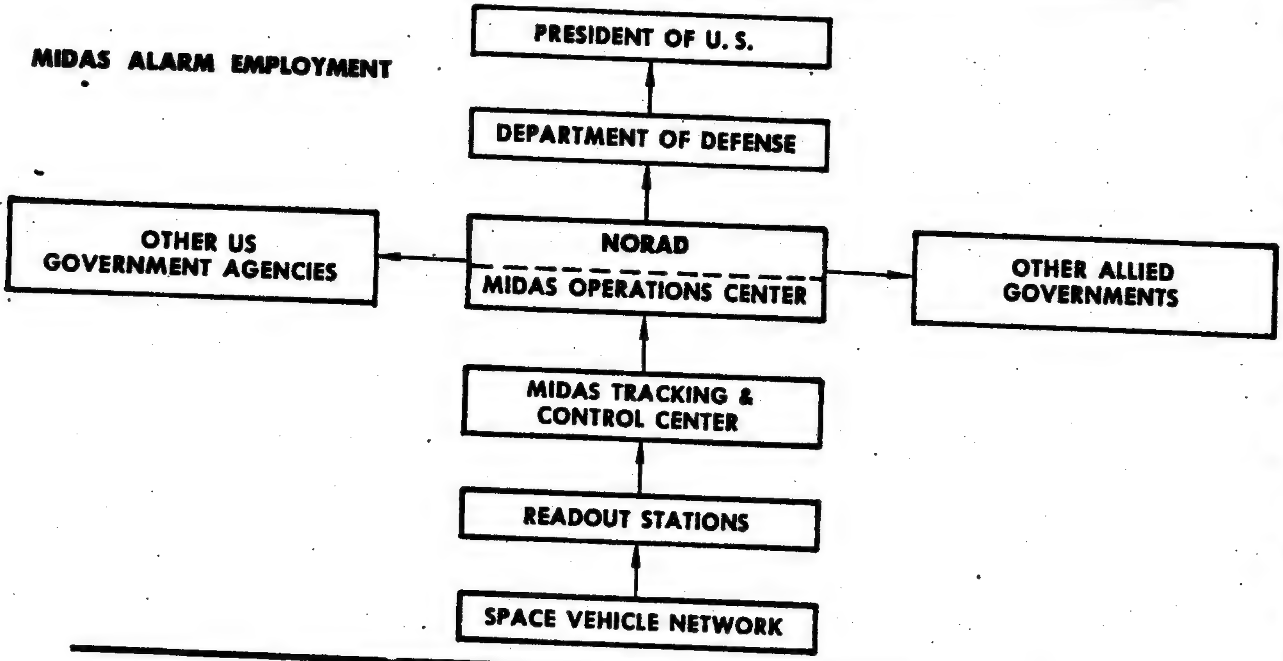


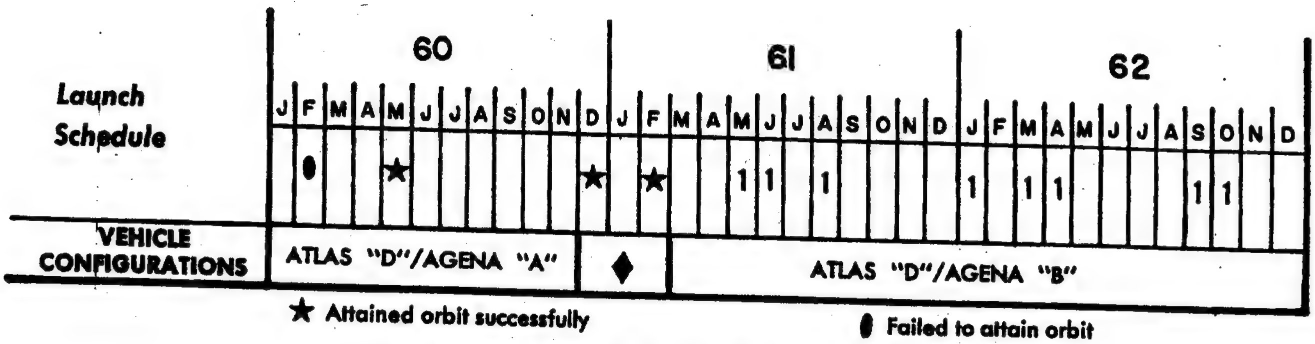
Probabilities of less than 1.00 on this map indicate the probability of at least one MIDAS satellite detecting an ICBM launch. Probabilities of 1.00 indicate that more than one MIDAS satellite will always be in position to detect an ICBM launch. These figures are based on geometric considerations of the family of satellites and ground readout station locations. Darker areas indicate most probable Russian ICBM launch site locations.

MIDAS ALARM EMPLOYMENT



CONCEPT

The MIDAS system is designed to provide continuous infrared coverage of the Soviet Union. Surveillance will be conducted by eight satellite vehicles in accurately positioned orbits. The area under surveillance must be in line-of-sight view of the scanning satellite. The system is designed to accomplish instantaneous readout of acquired data by at least one of three strategically located readout stations. The readout stations transmit the data directly to the MIDAS Tracking and Control Center where it is processed. It is then displayed and evaluated in the MIDAS Operations Center. If an attack is determined to be underway, the intelligence is communicated to a central Department of Defense Command Post for relay to the President and all national military and defense agencies.



★ Attained orbit successfully

⬮ Failed to attain orbit

◆ DISCOVERER vehicles carrying MIDAS radiometric payloads

Flight History

MIDAS No.	Launch Date	ATLAS No.	AGENA No.	Remarks
I	26 February	29D	1008	*Did not attain orbit because of a failure during ATLAS/AGENA separation.*
II	24 May	45D	1007	*Highly successful. Performance with respect to programmed orbital parameters was outstanding. Useful infrared data were observed and recorded.*
RM-1	20 December	DISCOVERER Vehicle		*Despite satellite oscillations, sufficient data were obtained for evaluation of payload operation. Information obtained in the 2.7- micron region agrees with data obtained from balloon-borne radiometric equipment. Data in the 4.3- micron region is somewhat higher than had been anticipated from theoretical studies.*
RM-2	18 February	DISCOVERER Vehicle		*All channels functioned properly and valid data were obtained on six stable orbits. Data confirmed previous radiometric measurements.*

MIDAS GROUND SUPPORT FACILITIES

Facility	*Equipment**	*Flight Function*
Satellite Test Center	ABCDEP	Operations control, orbit computations and predictions, initiation of commands to satellite (via tracking stations), process payload data.
Vandenberg AFB Tracking Station	ABCEFGHIJKLMP	Ascent and orbital tracking; telemetry reception; trajectory computations; command transmission; reception recording and processing of payload data.
Downrange Telemetry Ships	GHIJNO	Tracking and data reception during ascent. (Three ships are available for this function. Equipment is typical.)
Hawaiian Tracking Station	BEFGHJ	Orbital tracking, telemetry reception, payload data reception.
AMR	HJ	Orbital data reception.
New Hampshire Station	ABCEFGHIJKLM	Orbital tracking; telemetry reception; command transmission; reception, recording and transmission of payload data.
African Tracking Station	BEGJ	Telemetry reception and recording during second burn.
North Pacific Station	BCEHKMP	Satellite and payload data reception, command transmission.
Kodiak Tracking Station	FJ	Orbital tracking.
Mugu Tracking Station	BEFGJ	Tracking and telemetry reception.

NOTES: (1) In addition to equipment listed, all stations have inter- and intra-station communications equipment and checkout equipment.

(2) Equipment listed is either presently available or planned and approved for procurement.

**Equipment*

A. General Purpose Computer(s) and Support Equipment
B. Data Conversion Equipment
C. PICE
D. Master Timing Equipment
E. Control and Display Equipment
F. VERLORT
G. VHF FM/FM Telemetry Station
H. PAM FM Ground Station
I. Doppler Equipment
J. VHF Telemetry Antenna
K. UHF Tracking and Data Acquisition Equipment (60 foot F&D Antenna)
L. UHF Angle Tracker
M. UHF Command Transmitter
N. APL Doppler Equipment
O. SPQ-2 Radar
P. Midas Payload Evaluation and Command Equipment

Monthly Progress – MIDAS Program

Program Administration

- During the past month the MIDAS Program has undergone several major changes in program concept and management. The technical activity relative to the launch preparation for Series II has also increased.

- Program adjustments resulting from the guidance received from the Air Force Ballistic Missile and Space Committee have been resolved with the major contractors and local governmental agencies. Coordination of the adjusted program plan is currently being accomplished with the range facility, Pacific Missile Range. This plan, dated 31 March, will be printed early in April. It reflects the increased scope and program acceleration approved by the Air Force Ballistic Missile and Space Committee, adjusted to the funding guidance received. The launch schedule in this issue does not reflect the augmented launch program but has been time adjusted for compatibility with the 31 March plan.

- Concurrently with the preparation of the development plan, a vigorous program to document a "system package program" in response to the 375 series of Air Force regulations has been under way. Initial documentation and formulation of management organization and concepts are in progress. Analysis of these initial efforts reveal that there remains a considerable amount of data to be generated and inter- and intra-command coordination to be accomplished. The internal organization and management realignment resulting from the new structure of the Air Force Systems Command and the Air Force Logistics Command has had considerable impact on this effort. Results of this command structure and functional realignment will be incorporated into the documentation as they are identified and finalized.

Flight Test Progress

Radiometric Measurement Flight (RM-2)

- Analysis of data from the second radiometric flight conducted in February has provided valuable information despite vehicle tumbling and frequent signal loss. Limited data were obtained on all 2.7 and 4.3 micron channels and are in substantial agreement with the data received on the December radiometer flight. All payload, telemetry and reference channels performed satisfactorily.

- Signal dropout was more severe than during the RM-1 flight and the satellite tumbling seriously limited the amount of usable data received. However, during the second pass the Kaena Point, Hawaii, station received particularly good data in the 4.3 micron range. This data was of better quality than that obtained on the RM-1 flight. At this time the vehicle was stable and pitched downward at approximately 15 degrees. Data obtained by the Woomera, Australia, station on the fifth pass indicated that the vehicle was then tumbling. On the 13th pass, despite the tumbling of the satellite, the New Hampshire station acquired some valuable data. A final report on these data and an analysis of them will be published in late April. The final report on the RM-1 data analysis will also be published at that time.

Technical Progress

Boosters

- On 9 March, ATLAS booster 97D (MIDAS III) successfully completed a flight readiness firing at the Point Arguello Launch complex.

Second Stage Vehicles

- On 1 March, the AGENA vehicle for MIDAS III was successfully hot-fired on the Santa Cruz Test Base. On 21 March, the vehicle was shipped to Vandenberg Air Force Base. The vehicle is presently in the missile assembly building undergoing a preliminary checkout in preparation for the 19 May launch.

- The hot firing at Santa Cruz included a complete simulation of the AGENA boost and orbiting operation. The vehicle in the stand, with the payload installed, was subjected to simulated AGENA vibration followed by the program coast phase and then first burn of the engine cutoff and second coast phase with simulated orbital timing. The was followed by second burn cutoff and a simulated 2,000 nautical mile orbit. The payload was operated during the simulated orbit and the scanner was rotated throughout its entire travel. Checkout of the payload was accomplished through the regular command and data links. Performance was satisfactory throughout.

- During the hot firing tests at Santa Cruz several problems developed. A pressure transducer on the engine acid liner ruptured spraying acid into the aft equipment rack. The damage to the wire and equipment was repaired and system verification was accomplished. A guidance problem involving operation of the horizon sensor during periods of intense vibration was encountered during the tests. The guidance problem was solved and satisfactory performance by all systems was achieved.

- The AGENA vehicle for MIDAS IV is currently in the systems test phase. No problems are apparent at this time. The AGENA is scheduled for delivery to Santa Cruz Test Base on 28 April for flushing only. A mid-July launch date is forecast.

Infrared Scanners

- The Baird-Atomic, Inc. infrared detection payload for MIDAS IV has been shipped to Lockheed Missiles and Space Division (LMSD). This payload will be used in the payload-ground station compatibility tests to be conducted at Vandenberg Air Force Base in preparation for the MIDAS III flight.

- The Baird-Atomic payload for MIDAS V (Series II configuration) is scheduled for delivery on 2 May.

Background Radiometer Flights

- A series of U-2 airplane high altitude measurement flights conducted from Edwards Air Force Base has been successfully completed. Terrestial infrared radiation and horizon measurements were taken. The U-2 aircraft will presently be transferred to Alaska where a similar series of flights will be conducted to obtain measurements under Arctic conditions. A third series, designed to gather data under tropical conditions, will be conducted from Patrick Air Force Base, Florida.

Payload-Ground Systems Compatibility Tests

- Compatibility tests of the Baird-Atomic payload and the newly installed ground station equipment at Vandenberg Air Force Base will be conducted in April. For these tests an actual payload will be installed in the range safety station six miles from the ground readout installation.

Cathode Ray Tube Studies

- Investigations conducted by Lincoln Laboratories on TV-type image tubes have evolved a design for a potential application to MIDAS. Exploration of the design will be made in order to determine the operating hardware potential for advanced MIDAS concepts.

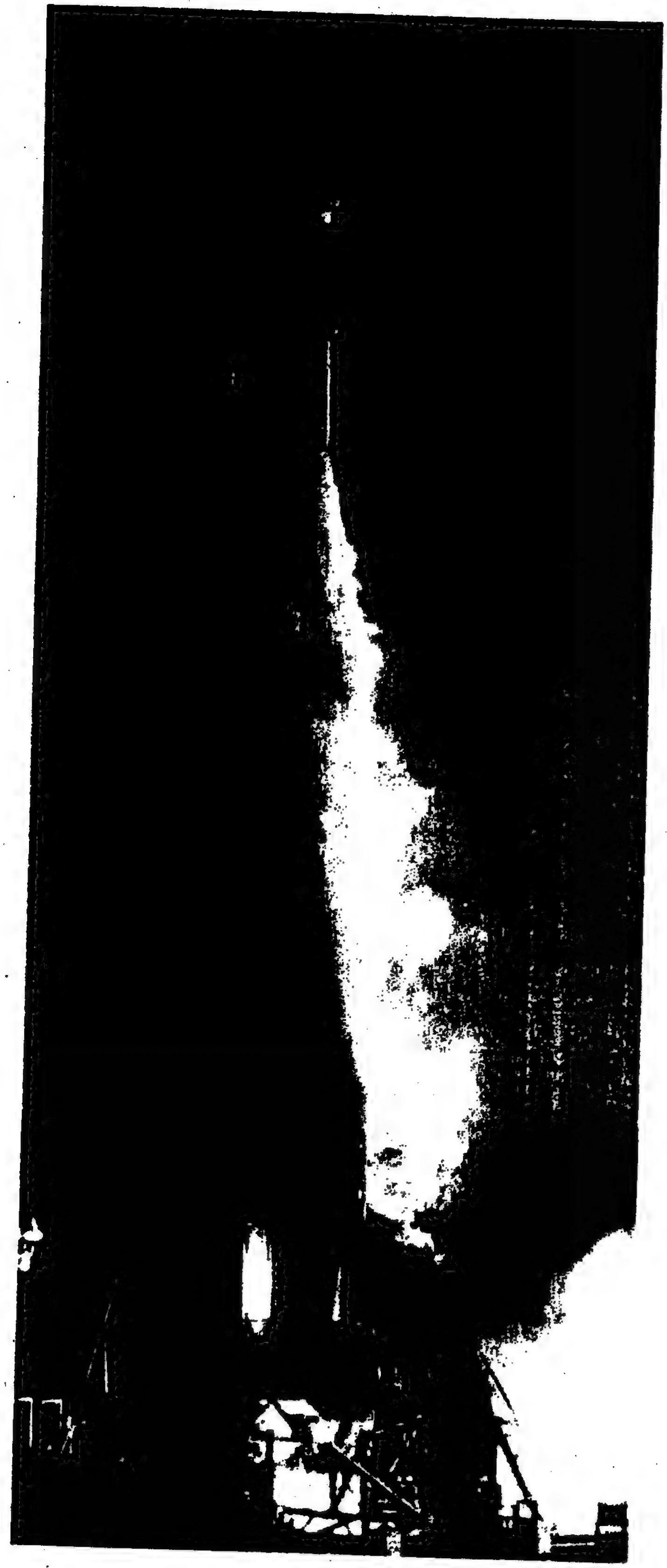


Figure 1. Flight readiness firing of ATLAS 97D at Point Arguello Pad 2.

Data Flow Analysis Subcontract Signed

- Negotiations with International Business Machines (IBM) were completed for analysis of anticipated data flow in the MIDAS Operational Center (MOC) and the Tracking and Control Center (TCC). Work on this subcontract will begin soon.

Facilities

- All launch complex facilities required to support MIDAS III will be ready for this flight. The Vandenberg Air Force Base missile assembly building was completed on 29 March. The launch site, Point Arguello Pad 2, is scheduled for completion on 7 April.
- Orbital tracking, telemetry, and control station installations are scheduled for completion by 7 May,

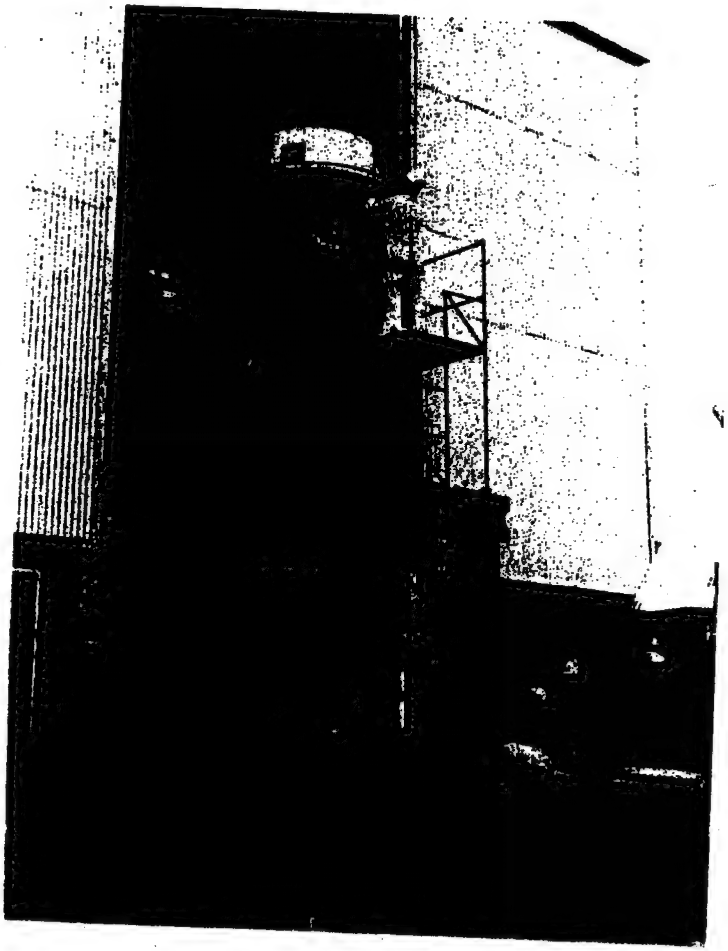


Figure 2. Closeup of the Baird-Atomic, Inc., payload mounted on AGENA vehicle during hot firing tests at Santa Cruz Test Base. Some of the AGENA guidance units are visible on the lower left of the photograph. The inertial reference package is on the far left and the reaction wheel assembly is the white circular unit in the lower foreground. The AGENA "B" vehicle (above) for the MIDAS III flight prior to installation in the Santa Cruz Test Stand for hot firing.

with the exception of the Southeast Africa station (Atlantic Missile Range station 13). This station will be ready on 17 May and will record AGENA second-burn data.

- LMSD has initiated design of facilities modification for the North Pacific readout station. These changes were caused by the revised equipment configuration.

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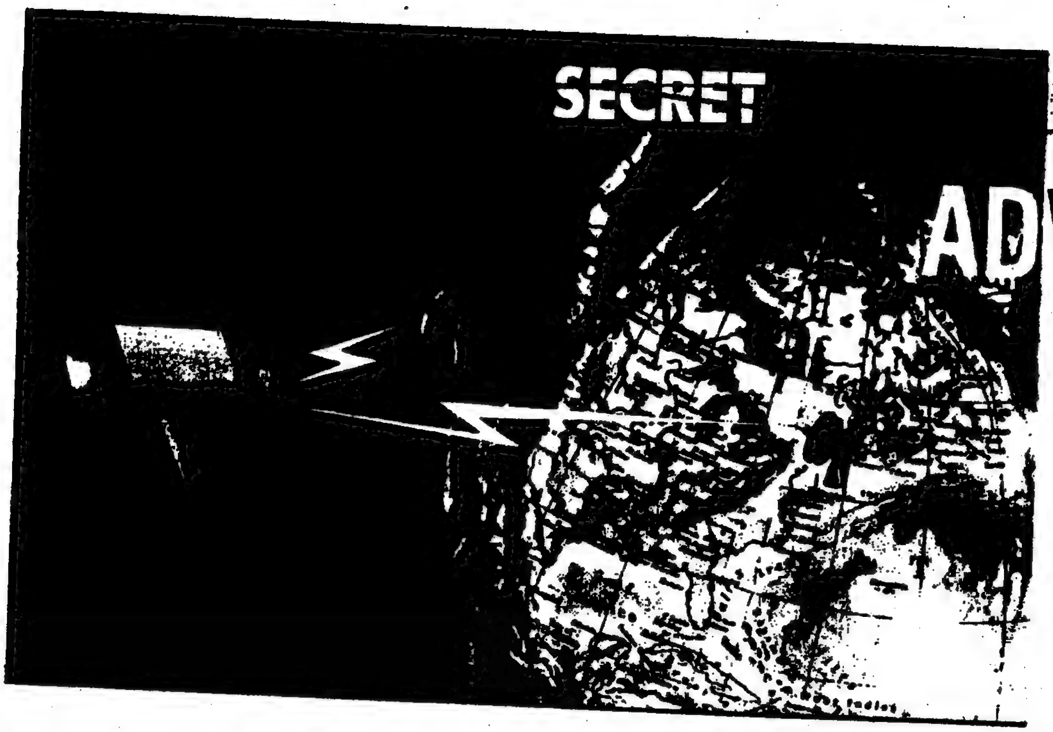
[redacted]

- Preliminary concept plans for the New Boston, New Hampshire MIDAS technical support buildings have been approved and the design effort was started on 20 March. The criteria review conference on the design of the Ottumwa, Iowa, tracking and control center was held on 15 March. Comments were forwarded to the architect-engineers for incorporation into the design plans.

Figure 3. Construction progress at the Southeast Africa tracking station (AMR Station 13) near Pretoria. This station will be ready to record AGENA second burn data on the MIDAS III flight.

SECRET

ADVENT



The ADVENT Program will investigate the feasibility of using satellites in synchronous orbit as instantaneous repeaters for microwave radio communications. A satellite vehicle station in synchronous equatorial orbit will remain in a fixed position relative to any point on the surface of the earth. Active communications equipment contained in this satellite will receive, amplify and instantaneously retransmit any message beamed in its direction.

PROGRAM HISTORY

The Research and Development program for active communication satellites was initiated by ARPA in January 1959. Following early research and development, a three-phased development program (STEER, TACKLE and DECREE) was initiated in May 1959 by Amendment No. 1 to ARPA Order No. 54. Phase I (STEER) was given priority in order to demonstrate the feasibility of providing an early UHF communications capability for positive control of the SAC strike forces. AFBMD was given responsibility for the design, development, and flight testing of the complete system, including launch, satellite tracking and control, and necessary support facilities and ground equipment. WADD and the U. S. Army Signal Research and Development Laboratory (USASRDL) were delegated responsibility for the development of the communications subsystem for Phase I and Phases II and III, respectively.

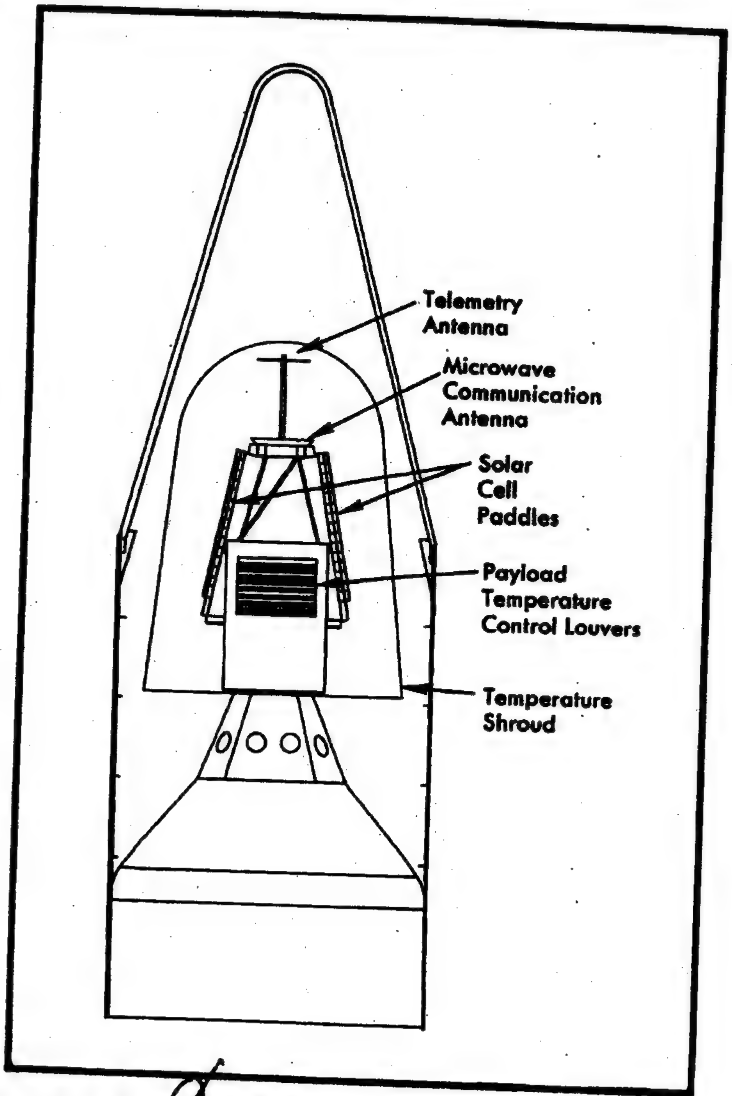

Telemetry Antenna
Microwave Communication Antenna
Solar Cell Paddles
Payload Temperature Control Louvers
Temperature Shroud

Figure 1. Proposed satellite with jettisonable fairing mounted on CENTAUR second stage.

~~CONFIDENTIAL~~ ~~SECRET~~

In April 1960, Amendment No. 5 to ARPA Order No. 54 reoriented the program. The research and development effort previously directed toward providing a ground-to-satellite-to-aircraft UHF communications capability for the SAC strike forces was cancelled. A single integrated ADVENT Program for the development of a 24-hour microwave communications satellite replaced the former STEER, TACKLE and DECREE Programs.

On 15 September 1960, the Secretary of Defense transferred over-all management responsibility for the ADVENT Program from ARPA to the Department of the Army. The development responsibilities of AFBMD and USASRDL were retained essentially status quo. The Army was given responsibility for funding and for over-all systems engineering to provide guidance and a basis upon which detailed design data can be evolved by AFBMD and USASRDL.

PROGRAM OBJECTIVES

The primary ADVENT objective is to demonstrate the feasibility of achieving a military system for microwave communications (surface-to-surface) employing satellite repeaters in 24-hour equatorial orbit. The feasibility of placing a satellite in predetermined position in a 19,300 mile equatorial orbit must be demonstrated. The feasibility of being able to stabilize the satellite, control its attitude and orbit, and keep it on station within the required tolerances must also be demonstrated. The satellite must be capable of providing worldwide communications on a real time basis at microwave frequencies with a wide bandwidth capacity. The Program Plan is based upon the design of a single configuration of a final stage vehicle compatible with launching by either AGENA "B" or CENTAUR second stage boosters.

The ADVENT Program, as defined in ARPA Order 54, Amendment No. 9, dated 11 August, will consist of the following flight tests, launched from the Atlantic Missile Range:

Phase One. Three ATLAS/AGENA "B" flights, nominal 5,600 nautical mile orbits, beginning March 1962.

Phase Two. Two flight tests, using payload space on NASA ATLAS/CENTAUR research and development flights numbers 9 and 10, December 1962 and February 1963.

Phase Three. Five ATLAS/CENTAUR flights launched into 19,300 nautical miles equatorial orbits, beginning March 1963.

Launch Schedule

	62												63												64					
	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J
			1			1			1							1		1	1		1		1		1		1			
Funded By	ARMY									NASA									ARMY											
Vehicle Configuration	ATLAS/AGENA "B"									ATLAS/CENTAUR																				

Monthly Progress — ADVENT Program

Technical Progress

- On 1 March a meeting was held at Convair Astronautics to discuss the performance and payload capability of the Centaur second stage. The U.S. Army Advent Management Agency (USAAMA) requested an explanation of the continued degradation of the NASA Centaur payload capability. The reasons for the reduction in payload capability are:

1. Increased weight of CENTAUR vehicle. The original wet inert weight was 3,143 pounds. However, the weight has increased during the two-year development period to 3,528 pounds. This 385-pound increase in inert weight results in a corresponding decrease in payload capability.
2. Performance of ATLAS/CENTAUR vehicle degraded. Because of a reduction in ATLAS/CENTAUR performance there is an additional 14-pound reduction in payload capability. The present CENTAUR payload capability is 838 pounds, a reduction of 399 pounds from the original estimate.

- The NASA Project CENTAUR Program management plan published on 8 March indicates a four-month slippage in launches #9 and #10. These vehicles will carry Project ADVENT orbital test vehicles.

- The final Lockheed Missiles and Space Division (LMSD) ADVENT/AGENA "B" Phase I work statement was received on 15 March. It is presently being reviewed to assure compliance with all agreements reached during the technical negotiation meeting of 3 March. Recommendations concerning this work statement will be forwarded to LMSD before 15 April for inclusion in the ADVENT contractual work statement.

- ADVENT/AGENA "B" Phase I launch preliminary trajectory and launch vehicle design criteria have been forwarded to Convair Astronautics and LMSD for use in analytical engineering studies and design of ADVENT launch vehicles. Meetings were held on 13 and 21 March with Aerospace Corporation and LMSD to insure that the latest weight figures were being used in trajectory studies.

- Before Space Systems Division could complete the technical evaluation of the Pratt & Whitney LR-119 Engine Proposal, NASA discontinued development of the engine. The LR-119 development was redirected toward the development of a common LR-115 engine for use with CENTAUR and SATURN. This engine will have a specific impulse of 420 minutes and a thrust of 15,000 pounds. New work statements are being prepared for transmittal to Pratt & Whitney, calling for LR-115 engines to be furnished for the ADVENT CENTAUR vehicles.

Final Stage Vehicle

- Interface meetings were held on 7-8 March at Ann Arbor, Michigan. Stage II design information consistent with the interface specification was distributed. Space Systems Division has directed General Electric/Missiles and Space Vehicles Department (GE/MSVD) to design, on the basis that the Bendix communication equipment will require power at 85 watts, 32 volts DC constant current. The constant current design criteria is valid only through the orbital test vehicle.

- On 17 March Space Systems Division and Aerospace Corporation participated in the USAAMA ADVENT Management meeting on orbital test vehicle and final stage vehicle weights. General Electric Engineering and Manufacturing Departments were assisted in establishing an internal weight control system in an attempt to reduce payload weights.

- A February 1962 activation date is forecast for the General Electric vacuum chamber which will be used for final stage vehicle heat flow tests. The first final stage vehicle is scheduled to start thermo tests in November 1961. General Electric is attempting to accelerate activation of this facility.

- Space Systems Division is currently reviewing justification for General Electric/MSVD's decision to develop a proton spectrometer within their organization.

Tracking, Telemetry and Command

- Representatives from Philco Corporation, Aerospace Corporation and Space Systems Division reviewed the Kaena Point, Hawaii, tracking station facilities. ADVENT facility requirements were discussed and antenna modifications were reviewed with 6593rd Instrumentation Squadron personnel. The addition of approximately 1,500 square feet of floor space to the present tracking and acquisition building will satisfy the ADVENT requirements. No problems are anticipated in the antenna modification except for the down time requirement to install the 400 MC feed and accomplish the required calibration. The 6593rd Squadron and Philco Corporation are arranging for scheduling and installation of the modification into the station operation schedule. The present station configuration appears adaptable to integration of the

ADVENT equipment with no major problems. Preliminary design of the addition to the UHF acquisition building was started in March.

- On 7-9 March, Aerospace Corporation and Space Systems Division personnel attended the Air Force Missile Test Center range user conference at Orlando Air Force Base. Valuable information about range instrumentation and data reduction capability of the Atlantic Missile Range was obtained.

Facilities

- The ADVENT addition to the Vandenberg Air Force Base UHF receiver building has been deleted from the program.

- Atlantic Missile Range Hangar A-A will be modified to support the General Electric ADVENT prelaunch requirements. Office space will be provided in a portion of Hangar F.

BOOSTER

support programs

ABLE
TRANSIT
MERCURY
BLUE SCOUT
DYNA SOAR
NASA AGENA "B"
VELA HOTEL

Able Projects

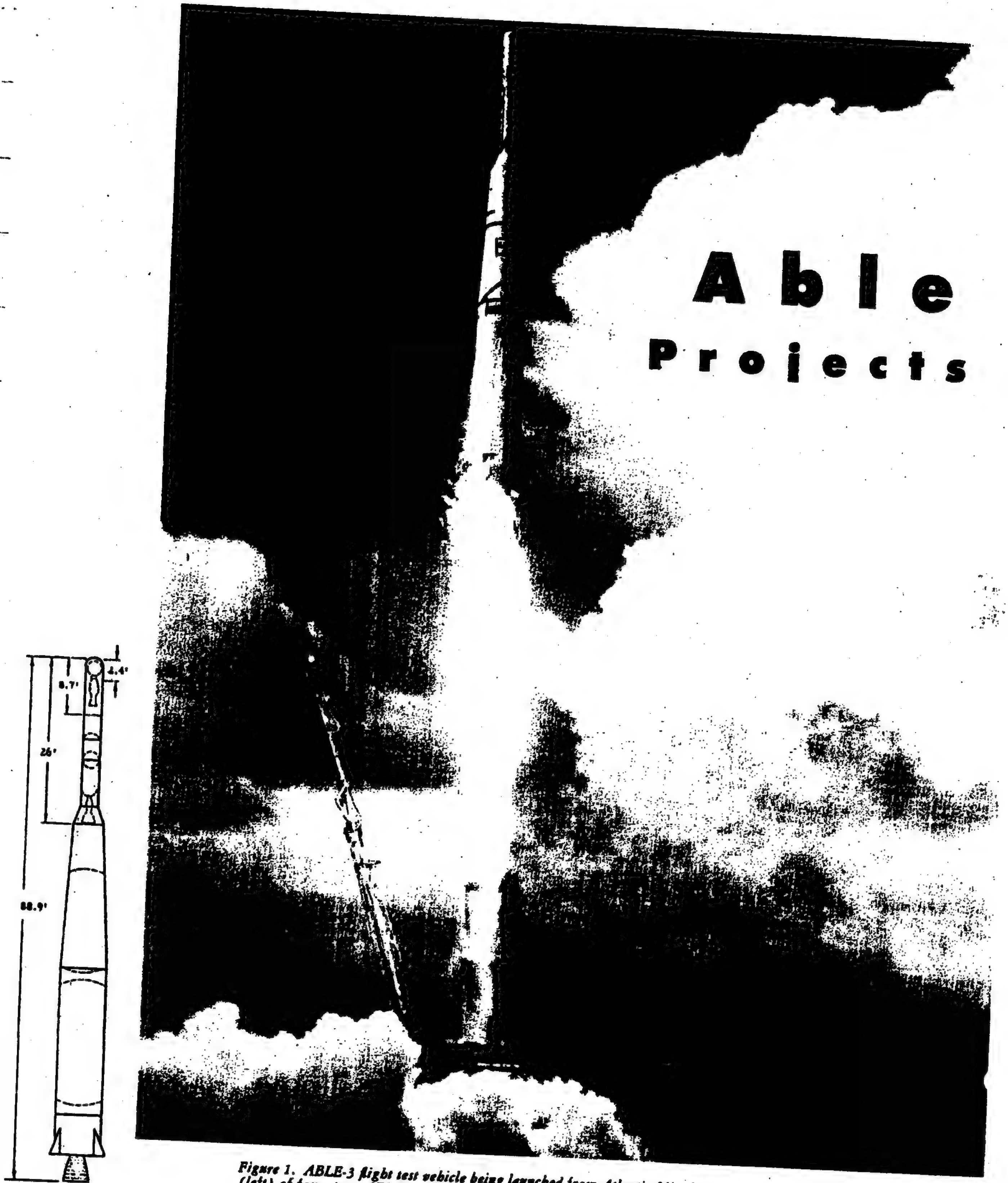
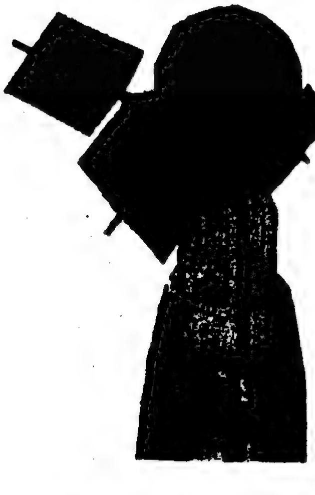


Figure 1. ABLE-3 flight test vehicle being launched from Atlantic Missile Range. Dimensional drawing (left) of four-stage ABLE-3 vehicle.

The ABLE series of space probes was initiated with ABLE-1 program in March 1958. This program, undertaken by AFBMD under direction of the Advanced Research Projects Agency, had as its over-all objective, the acquisition of data on the extra-terrestrial space environment. The design and construction of a four-stage space vehicle was initiated. The vehicle, consisting of a THOR IRBM first stage, an ABLE second stage, ABL-248 solid propellant third stage and the satellite vehicle fourth stage was successfully demonstrated in the fall of 1958. In October 1958, the National Aeronautics and Space Administration, given cognizance over the space exploration effort, authorized the ABLE-3 and ABLE-4 programs. General objectives included the demonstration of vehicle and communications capability and performance of scientific research experiments over interplanetary distances. An extensive network of ground support stations was simultaneously established, the most powerful of which is the 250-foot antenna at the Jodrell Bank Experimental Station, University of Manchester, England. Central control and data computation is accomplished at the Space Navigation Center, Los Angeles, California, and other military and NASA centers assisting in tracking and telemetry according to the specific requirements of each mission. The ABLE-4 program led to the development of a space booster utilizing the ATLAS ICBM as the first stage, providing a greatly increased payload capacity. A hydrazine engine with multi-start capability was developed for the ATLAS boosted vehicles to permit mid-course vernier control and to provide controlled thrust to inject the vehicle into orbit about another planet. Under the ABLE-3 and 4 programs, a solar cell power supply system was developed and extensive original design of satellite vehicle command, telemetry, and communication equipment was accomplished.

ABLE-1—The ABLE-1 program consisted of three flights with the object of placing a payload within the moon's gravitational field. The ABLE-1 four-stage vehicle consisted of three booster stages and a terminal stage composed of eight vernier rockets, an orbit injection rocket (solid propellant TX8-6) and a payload. The booster stages were THOR first stage, Advanced Re-entry Test Vehicle (AJ10-101 engine) second stage, and a third stage utilizing the ABL X-248-A3 solid propellant rocket engine. The first lunar probe was launched on 17 August 1958. The flight was normal until 73.6 seconds after liftoff when a turbopump bearing failure caused the booster to explode. The second lunar probe was launched on 10 October 1958. Although the payload did not reach the vicinity of the moon, a maximum altitude of 71,700 statute miles was attained and useful scientific data were obtained from the instrumentation. The third lunar probe was launched on 8 November 1958. Because the third stage failed to ignite, the maximum altitude attained was 970 statute miles. The primary program objectives, obtaining scientific data in cislunar space, were achieved by the October flight.



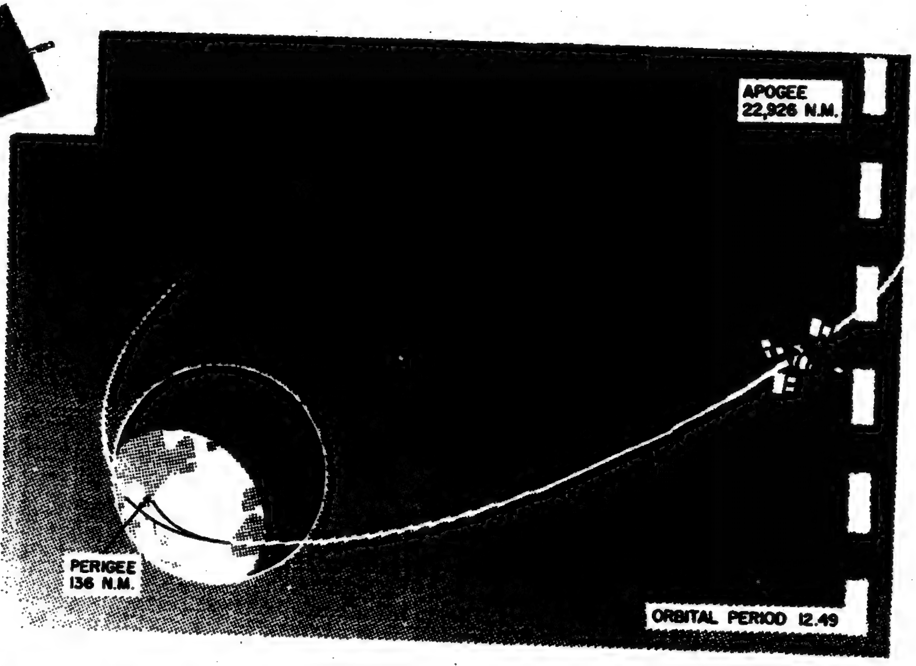


Figure 2. ABLE-3 third stage and payload (above) with solar paddles fully extended. Drawing of extremely elliptical orbit achieved by ABLE-3 (EXPLORER VI).

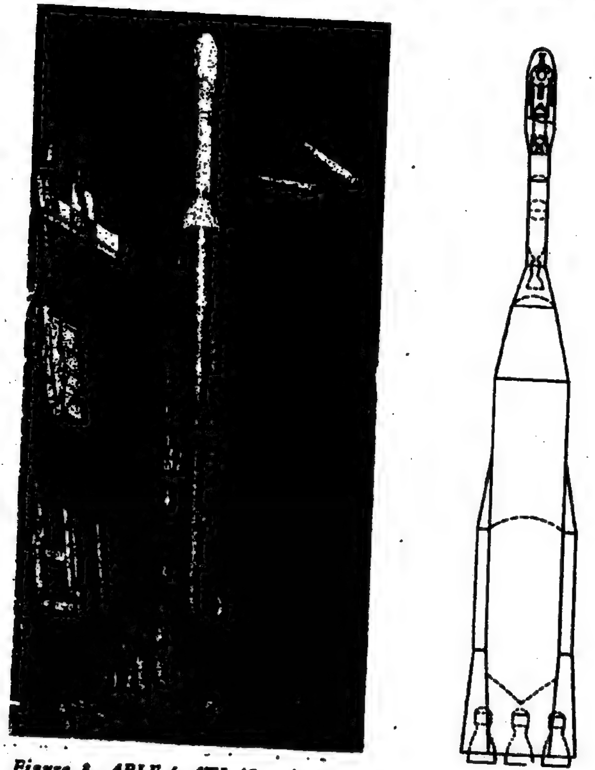


Figure 3. ABLE-4 ATLAS vehicle configuration drawing and photo of vehicle installed on Atlantic Missile Range launch stand 12.

ABLE-3—This four stage flight vehicle was launched from the Atlantic Missile Range on 7 August 1959. The vehicle consisted of a THOR booster, a second stage using the AJ10-101A rocket engine, a third stage powered by the ABL-248-A3 engine, and a fourth stage consisting of the payload and an injection rocket. In addition to carrying a highly sophisticated payload, the ABLE-3 (EXPLORER VI) flight was used to demonstrate the validity of the ABLE-4 vehicle and component configurations. All phases of the launching were successful and the advanced scientific observatory satellite was placed in an extremely elliptical geocentric orbit. Trajectory and orbit were essentially as predicted with deviations in apogee and perigee well within the range of expected values. The payload was the most sophisticated to have been placed in orbit by this nation at the time and contained provisions for conducting 13 experiments in space environment and propagation. A wealth of valuable data was obtained from satellite telemetry until the last transmission was received on 6 October. Among the significant achievements of EXPLORER VI were:

1. The first comprehensive mapping of Van Allen radiation belts.
2. The first study of dumping and filling of outer Van Allen radiation belts during a magnetic storm.
3. The first still TV photo of earth from a satellite.
4. The first computer (Telebit) operating in space with instrumentation.
5. The first direct flux measurements of low-energy electrons in the outer radiation belt.
6. Discovery of large electrical current system in the outer atmosphere.
7. Discovery of betatron acceleration in outer atmosphere.

It is believed that the satellite, while yet in orbit, is incapable of generating sufficient power for transmitting signals due to solar paddle damage suffered during initial paddle extension and the resultant unfavorable sun "look" angle.

ABLE-4 ATLAS—This vehicle differed from the ABLE-3 primarily in that an ATLAS ICBM was used as the first stage instead of a THOR IRBM, permitting installation of a hydrazine engine for midcourse velocity corrections and to accomplish the ejection of the satellite into lunar orbit. The unsuccessful launch of the ABLE-4 ATLAS occurred on 26 November 1959. Structural breakup resulted in the third stage and payload parting from the vehicle approximately 48 seconds after launch. The ATLAS performed as planned over its entire powered flight trajectory. The trajectory of this flight, from the Atlantic Missile Range to the vicinity of the moon, was established to achieve the tightest possible circular lunar orbit consistent with the highest probability of success. The final burnout conditions were to have provided an inertial velocity of 34,552 feet per

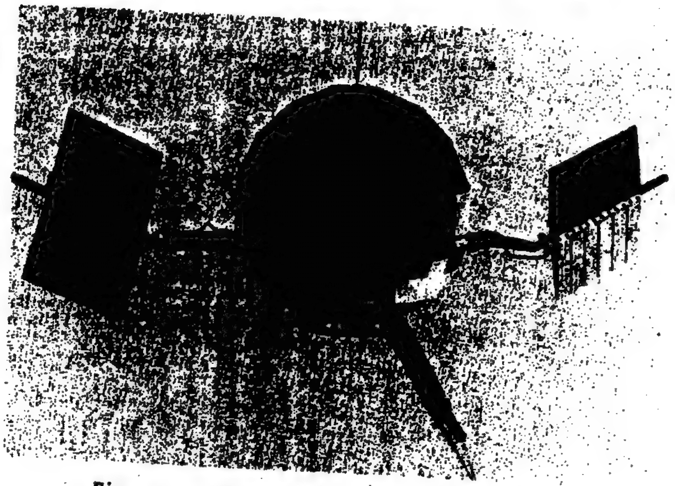
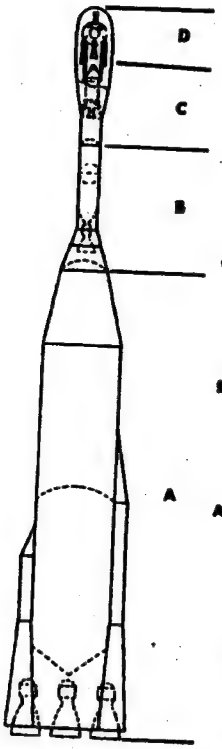


Figure 4. PIONEER V satellite vehicle shown in orbital flight position. This solar satellite was launched from the Atlantic Missile Range on 11 March 1960.



D. Satellite Vehicle	
Gross Weight	380.2 lb
Gross Weight (Burnout)	229.4 lb
Specific Impulse (vac)	230 sec
Thrust (vac)	18.3 lb
C. THIRD STAGE ABL 248-A9	
Gross Weight	903.2 lb
Gross Weight (Burnout)	547.4 lb
Specific Impulse (vac)	250.5 sec
Thrust (vac)	3100 lb
B. SECOND STAGE AJ 10-101	
Gross Weight	5107.3 lb
Gross Weight (Burnout)	1816.1 lb
Specific Impulse (vac)	268 sec
Thrust (vac)	7575 lb
A. FIRST STAGE ATLAS "D"	
Gross Weight	266,390 lb
Gross Weight (Burnout)	11,790 lb
Thrust (S. L.)	316.5 sec
Specific Impulse (vac) Sustainer	81,863 lb
Thrust (vac) Sustainer	290.6 sec
Specific Impulse (vac) Booster	251 sec
Specific Impulse (S. L.) Booster	367,787 lb

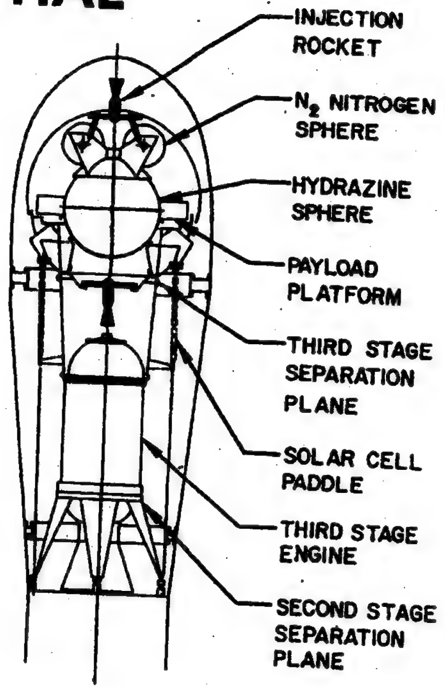
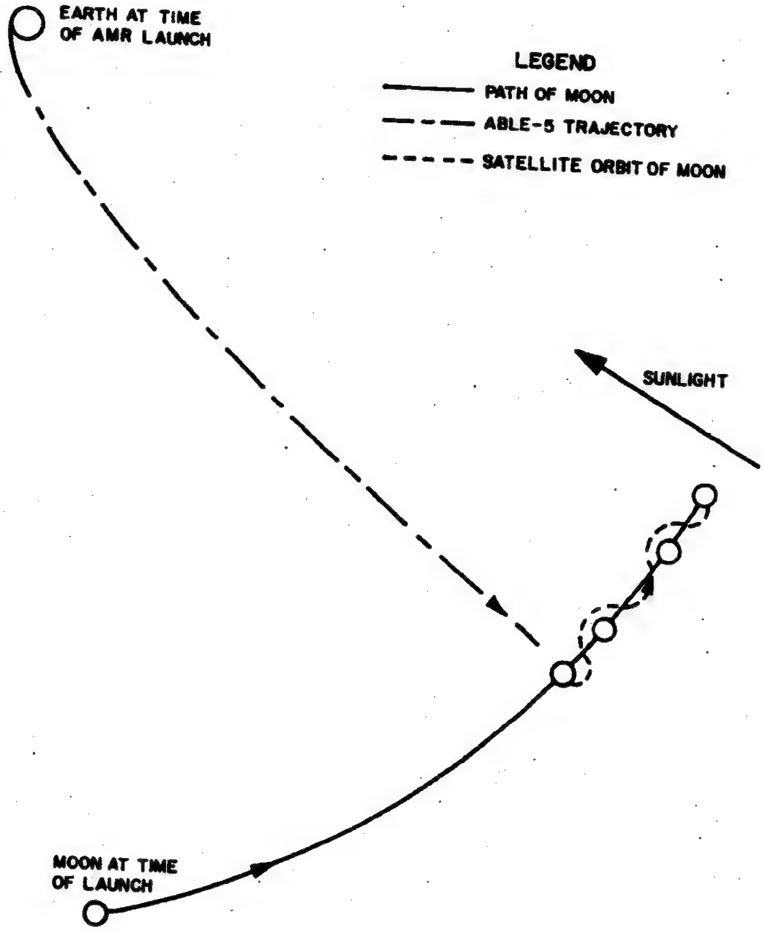


Figure 5. ABLE-5 vehicle configuration drawing and specification list. Third stage and payload configuration (right). Trajectory of ABLE-5 into lunar orbit is shown in drawing (below).

second. The payload was designed to investigate space environment and propagation effects and to transmit crude television images of the far side of the moon. This was the first flight in which an ATLAS ICBM was used as the booster for a multi-stage space flight.

ABLE-4 THOR—This vehicle was launched on 11 March from the Atlantic Missile Range and succeeded in placing the PIONEER V satellite into a solar orbit. At its closest approach to the sun, the satellite will pass near the orbit of Venus, and return to intersect the orbit of earth at its greatest distance from the sun. The vehicle consisted of a THOR first stage, ABLE second stage with AJ10-101 liquid fueled propulsion system and an STL guidance system, and an ABL-248A-3, solid fuel third stage. The 95 pound payload contains instrumentation for conducting scientific experiments related to magnetic field and radiation phenomena in deep outer space. At 0733 hours EST, on 26 June, the last radio signal was received from PIONEER V. The transmitter has been operated throughout the three and one-half month period and has demonstrated that, except for the batteries, the communications link could have been maintained for a distance significantly greater than the 50 to 60 million miles originally estimated. At the time of the last transmission the vehicle was 22,462,000 miles from earth.



Our knowledge of space, of the sun, and of the solar system has been substantially increased by the information transmitted by PIONEER V. Analysis of the data obtained during the satellite's journey into space has revealed the following major scientific discoveries:

1. An interplanetary magnetic field exists with a steady magnitude of more than one Gamma and a peak of up to ten Gamma. This field fluctuates in a manner that is connected to solar flare activity.
2. The planar angle of the interplanetary magnetic field forms a large angle (about 90 degrees) with the plane of the elliptic.
3. The exospheric ring current of 25,000 miles diameter encircles the earth as a giant doughnut at a distance of 40,000 miles from earth. The five million ampere current moves westward around the earth.
4. The geophysical magnetic field extends at times to 65,000 miles and this field oscillates in intensity in the outermost exosphere.
5. The sudden decrease in galactic cosmic rays (the Forbush decrease) always associated with large solar flares does not depend on the presence of the earth's magnetic field. This unexpected discovery will require formulation of a new theory to explain the Forbush decrease.
6. Penetration radiation in space is not limited to the Van Allen belts. At least during periods of solor activity 5 to 50 Roentgens per hour are incident on the satellite.
7. Energetic particles in the Van Allen radiation belts are not ejected directly from the solar wind. Some process for particle acceleration must exist in the belt.

ABLE-5

The ABLE-5 program provides for launch of two ATLAS-ABLE vehicles to place satellites into lunar orbits late in 1960. A proposed ATLAS/ABLE lunar program was submitted to AFBMD by NASA on 4 February 1960, following discussions between AFBMD and the NASA Goddard Space Flight Center in January.

Program Objectives

1. Place a satellite into lunar orbit with an apolune of 2,500 nautical miles and perilune of 1,400 nautical miles.
2. Maintain adequate earth-satellite communications and establish communications parameters for future space probes.
3. Demonstrate effective guidance system performance, particularly for the satellite vehicle.
4. Successful conduct of payload experiments.

Program Vehicle (Figure 5.)

First Stage—ATLAS series D missile General Electric/Burroughs Corp. Mod 3 guidance system.

Second Stage — ABLE vehicle with Aerojet-General AJ10-101A propulsion system.

Third Stage—Allegany Ballistic Laboratory ABL-248 solid propellant rocket, unguided, spin stabilized by spin rockets fired at termination of second stage thrust.

Fourth Stage (Satellite Vehicle)—Space Technology Laboratories designed, incorporating an injection rocket capable of being restarted four times to increase payload velocity and two times to decrease payload velocity. The satellite also contains a telemetry system (capable of continuous operation), four solar cell paddles, and scientific equipment for conducting the experiments. Satellite vehicle weight is 380 pounds.

Launch and Powered Flight

These vehicles will be launched from the Atlantic Missile Range on a true azimuth of 98.0 degrees. ATLAS performance parameters have been based on results obtained from Series "D" R&D flight tests. Parameters for all four stages are shown on figure 5. Final burnout of ABLE-5A was programmed to occur 23,971,428 feet from the center of the earth at an inertial velocity of 34,051 ft./sec. Final burnout for ABLE-5B was programmed to occur 23,927,683 feet from the center of the earth at an inertial velocity of 33,901 ft./sec.

Orbital Characteristics — ABLE-5A

Major Axis	0.3470×10^8 feet
Eccentricity	0.190
Orbital period	575 minutes
Apolune	2,460 nautical miles
Perilune	1,380 nautical miles
Duration of eclipses	less than 90 minutes

Orbital Characteristics — ABLE-5B

Major Axis	0.33388×10^8 feet
Eccentricity	0.1854
Orbital period	543 minutes
Apolune	2,318 nautical miles
Perilune	1,300 nautical miles
Duration of eclipses	less than 90 minutes

Payload Experiment

Scintillation Counter and Pulse Height Analyzer — measure electron energy (greater than 100 KEV per particle) and proton energy (greater than 2.0 MEV per particle).

Ion Chamber and Geiger-Muller Tube — flux and rate data for electron particles (greater than 1.25 MEV per particle) and proton particles (greater than 20 MEV per particle).

Proportional Counter Experiment — measure integrated intensity of cosmic ray particles: electrons (greater than 12 MEV per particle) and protons (greater than 75 MEV per particle).

Spin Search Coil Magnetometer and Phase Comparator — map the magnetic field (normal to vehicle spin axis) and investigate very low frequency secular magnetic field variations. Phase comparator circuit uses Spin Search Coil and Flux Gate inputs to determine magnetic field direction relative to inertial space.

Flux Gate Magnetometer — measure magnetic field parallel to vehicle spin axis.

Micrometeorite Flux and Momentum Experiment — count impacts of micrometeorites and interplanetary dust particles on two differing thresholds.

Plasma Probe Experiment — measure the energy and density of streams of protons having energies of the order of a few kilovolts per particle.

Low Energy Scintillation Counter — measure the flux intensity of electrons above 50 KEV and protons above 500 KEV.

Solid State Detector — (carried on ABLE-5B in addition to the above experiments) measure the flux of protons of energies from 0.5 to 9 MEV.

Ground Support Program

Atlantic Missile Range — track vehicle for first 12 hours after launch (except for a three hour period starting a few minutes after liftoff), provide ATLAS guidance, provide first vernier correction for payload stage.

Manchester, England — track vehicle for 6 hours, starting 13 minutes after launch, provide second vernier correction for payload stage (and additional corrections as required).

South Point, Hawaii — track vehicle for 11 hours starting 6 hours after launch, transmission of commands, including vernier corrections as necessary. Other support stations that will track and record data from the vehicle during periods of tracking by the primary stations include Singapore, Goldstone, Millstone Hill, and NASA minitrack stations. Central control and data collection for the flight will be accomplished at the Span Center at Los Angeles.

ABLE-5A — The vehicle configuration and trajectory for this flight are given in Figure 5. The unsuccessful launch of the ABLE-5A vehicle occurred on 25 September at 0713 PST. The launch had been postponed for one day because of high winds and unfavorable weather in the launch area. The countdown was normal and the flight proceeded as planned through the completion of first stage operation. Performance of the ATLAS booster was excellent with all systems operating properly. ATLAS sustainer engine cutoff occurred 271.7 seconds after liftoff and Stage I/II separation occurred 1.5 seconds later. However, a malfunction occurred at second stage ignition, causing a substantial loss in thrust and subsequent loss of control, and as a result, the objectives of this flight were not met.

ABLE-5B — Technical difficulties with the ground support equipment caused a one-day postponement of the flight. On 15 December, at 0110 PST, ABLE-5B was launched from the AMR. Powered flight appeared normal until approximately 67 seconds after liftoff. The flight test data indicate that all measured parameters were normal until T plus 66.7 seconds, when a transient was noted in the first and second stage axial accelerometers, followed by a decrease in booster liquid oxygen pressure. Film data show a change in flame pattern at this time, followed by structural failure of the combined vehicle, resulting in impact 8-12 miles off shore. Examination of recovered structure revealed no second stage propellant leakage or combustion. The cause of the malfunction has not been determined.

Monthly Progress — ABLE Program

ABLE-5B Flight Analysis

- Since the failure of ABLE-5B approximately 67 seconds after liftoff on 15 December the ATLAS/ABLE-5B Review Group, which consists of representatives from Aerospace, Space Technology Laboratories, Aerojet, Rocketdyne, Convair, National Aeronautics and Space Administration, and the Space Systems Division has been charged specifically with the task of analyzing and evaluating data and conducting tests to determine mode and mechanism of failure of the ATLAS/ABLE-5B flight. The program established to accomplish this task has been conducted in three phases:

Phase I — Consisted of the collection, calibration, and analysis of all data to provide a common time basis, establish data validity, and determine the mode of vehicle failure.

Phase II — Consisted of analysis and evaluation of data to identify the mechanism(s) which could have caused the mode of failure as established in Phase I.

Phase III — Consisted of test programs designed to prove the validity of the hypotheses relative to the mechanism(s) identified in Phase II.

- On 15 February the ATLAS/ABLE-5B Review Group completed Phase II of the flight evaluation. The review group has also completed Phase III which consisted of test programs designed to prove the validity of the hypotheses relative to the mechanism(s) which could have caused the failure. Two hypotheses were retained which could explain the mechanism of failure. These are: a failure of the ATLAS liquid oxygen tank as the first incident; or the loss of a portion of the upper stages as the first incident which subsequently struck the ATLAS liquid oxygen tank, causing it to fail. Members of the Review Group have received drafts of the final reports and upon receipt of their comments the final report will be published.

- NASA has established a requirement for additional ABLE-5 failure analysis. A small group will be established to analyze the photographic and telemetry records of both the ABLE-5B flight and the MA-1 flight in an effort to determine if any correlation exists between the failures.

Facilities

- Equipment from the ABLE overseas tracking stations is being returned to McClellan Air Force Base to await disposition. Much of the equipment from the Singapore Station has been returned and the station has been deactivated. Pacific Missile Range personnel are being trained in the operation of the South Point, Hawaii, station. This station was turned over to the Pacific Missile Range on 3 April.

Transit

A. THIRD STAGE—X-248 (Allegany Ballistic Lab.)

Thrust at altitude	3150 pounds
Specific impulse (vac)	250 seconds
Total impulse	116,400 lbs/sec
Burning Time	37.5 seconds
Propellant	Solid

B. SECOND STAGE—AJ10-42 (Aerojet-General)

Thrust at altitude	7700 pounds
Specific impulse (vac)	271 seconds
Total impulse (min)	870,000 lbs/sec
Burning time	115 seconds
Propellant	Liquid

C. FIRST STAGE—THOR IRBM

Thrust (s. l.)	151,500 pounds
Specific impulse (s. l.)	248 seconds
Specific impulse (vac)	287 seconds
Burning time	158 seconds
Propellant	Liquid

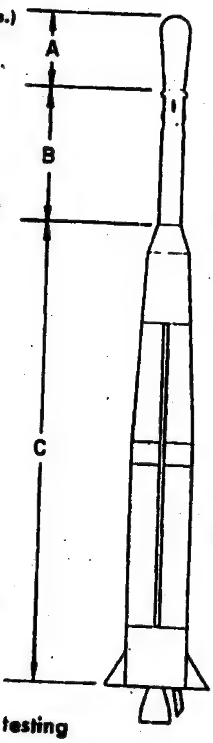


Figure 1. TRANSIT 1A three stage flight vehicle.

TRANSIT 3A launched from Atlantic Missile Range

The TRANSIT Program consists of the flight testing of nine vehicles to place 200-270-pound satellite payloads into circular orbits of 400 to 500 nautical miles. The program is designed to provide extremely accurate, world-wide, all-weather navigational information for use by aircraft, surface and subsurface vessels, particularly in relation to POLARIS missile firings. The ARPA Order for TRANSIT 1A was initiated in September 1958 and amended in April 1959 to add TRANSIT 1B, 2A and 2B flights. The TRANSIT 3A and 3B flights were initiated by a Navy MIPR, dated 18 May 1960. Because of the successful TRANSIT 2A launch and excellent payload performance the Navy has elected to launch TRANSIT 3A rather than 2B. TRANSIT 2B was scheduled to carry the same type payload as was carried on the 2A flight. Subsequently, the Navy initiated requests for TRANSIT 4A, 4B, 5A and 5B.

The program was originally authorized by ARPA Order No. 97-60, which assigned AFBMD responsibility for providing the booster vehicles, integrating payloads to the vehicles, and flight operations from launch through attainment of orbit. The TRANSIT project was transferred to the Navy on 9 May 1960. The Navy has now assumed both the administrative and technical responsibility for the TRANSIT program. Payload and tracking responsibility has been assigned to the USN Bureau of Weapons. Applied Physics Laboratory is the payload contractor.

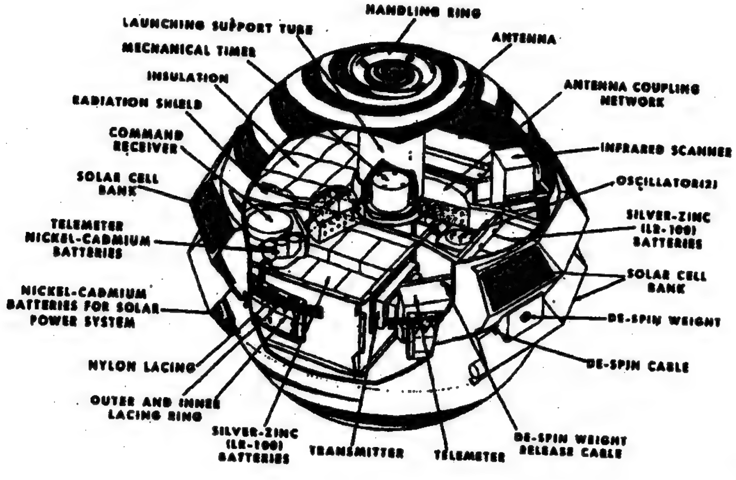
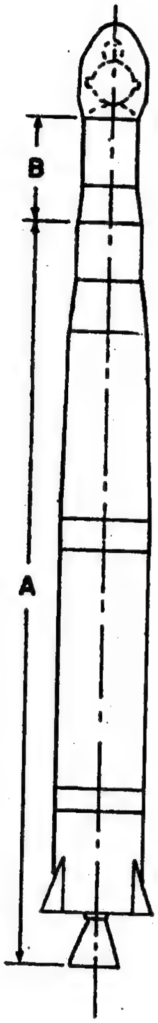


Figure 2. Cut-away drawing of TRANSIT 1A payload (NAV 1).



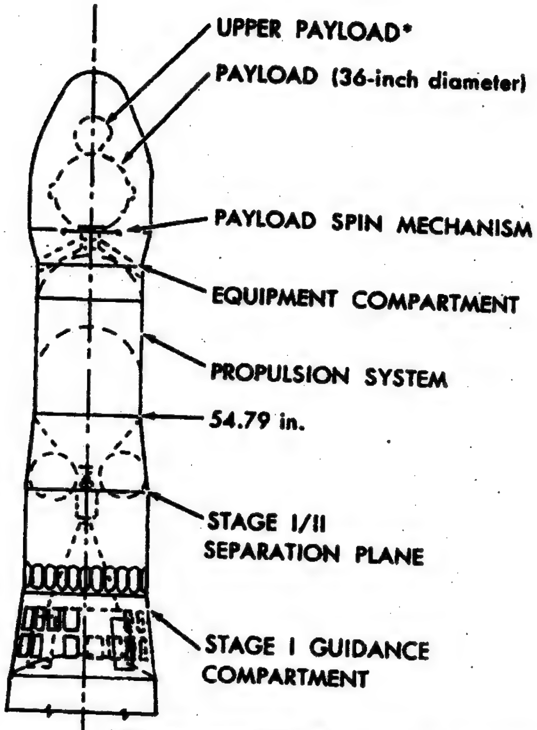
B. SECOND STAGE — ABLESTAR (AJ10-104)

Thrust at altitude	7752 pounds
Specific impulse (vac)	278 seconds
Total impulse (min)	2.3 × 10^6 lbs/sec
Burning time	294 seconds
Propellant	Liquid

A. FIRST STAGE — THOR IRBM

Thrust (s. l.)	151,500 pounds
Specific impulse (s. l.)	245 seconds
Specific impulse (vac)	287 seconds
Burning time	158 seconds
Propellant	Liquid

Figure 3. Two-stage vehicle used for TRANSIT 1B and subsequent flights.



*20-inch diameter (TRANSIT 2A and 3A)

Program Objectives

1. Provide accurate navigational reference information for POLARIS launches.
2. Precise determination of satellite position by measuring the doppler shift of satellite transmitted radio signals.
3. Investigate the refractive effect of the ionosphere on radio transmissions.
4. Acquire additional geodetic and geographical data by precision tracking of the orbiting satellite.

Flight Vehicles TRANSIT 1A was a three stage vehicle as shown in Figure 1. TRANSIT 1B and subsequent vehicles are two stage vehicles as shown in Figure 3.

Launch Plans All vehicles will be launched from Complex 17 at the Atlantic Missile Range. Launch azimuth will vary between 44.5° and 140° for each flight.

Payload Description The TRANSIT payload is a spherical package with a bank of solar cells at the equator. The payload weight has increased with successive vehicles from 200 to 300 pounds for TRANSIT 3B. The payload contains four stable-frequency transmitters. Frequencies used on various flights are 54, 108, 162, 216, and 324 mc. Power is supplied by batteries and solar cells. Future plans call for a memory unit in the satellite which will receive orbital parameters transmitted from the ground, store them and read out on command from a user who will navigate with the aid of the satellite system. The TRANSIT 3B payload will contain a permanent magnet which will cause the satellite to be oriented along the lines of the earth's magnetic field after its spin rate has been reduced. Some of the TRANSIT payloads contained experiments from other agencies. Also, TRANSIT 2A and 3A carried GREB, a 21-inch sphere weighing about 40 pounds, which studied solar emissions. TRANSIT 3B will carry LOFTI, a 20-inch sphere weighing approximately 50 pounds which will study the attenuation of very low frequency radio transmission through the ionosphere.

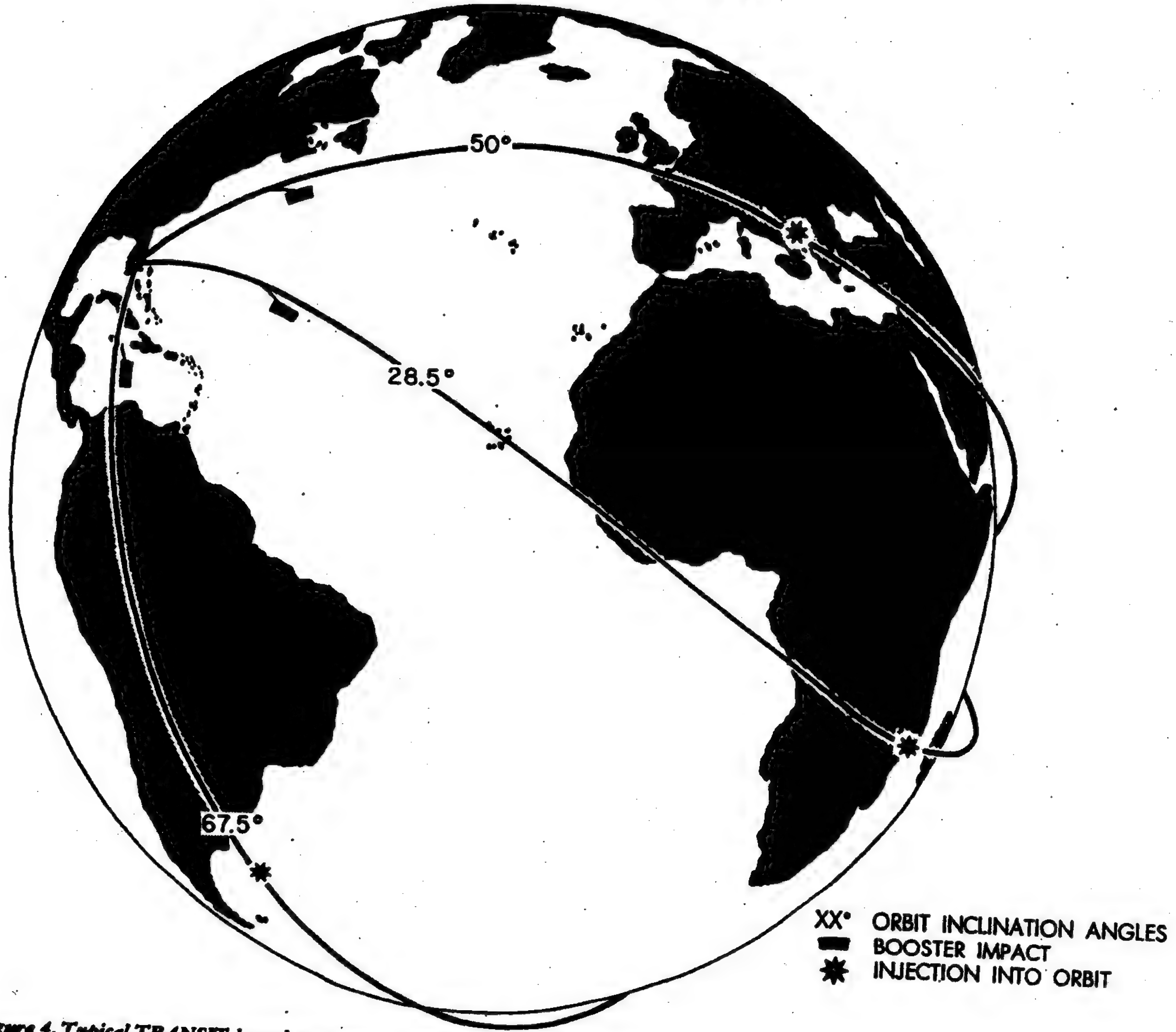
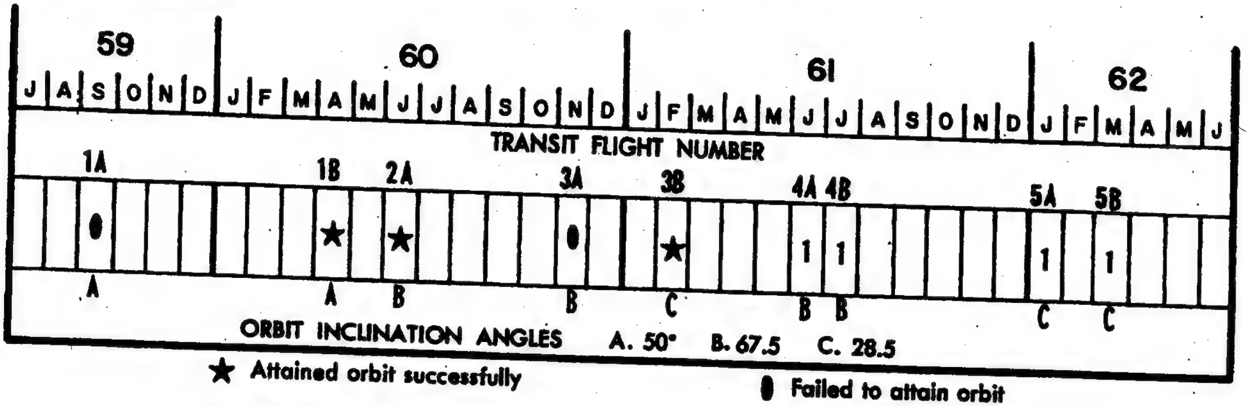


Figure 4. Typical TRANSIT launch trajectories showing flight path, booster impact areas, and orbital injection points.

Orbital Performance Achievement of program objectives is based primarily on measuring the doppler shift of satellite transmitted radio signals. During the first three months of flight, the four transmitters will be operated to obtain experimental confirmation of the theoretical mathematical relationship between the frequency and the refractive index of the ionosphere. Studies have shown that refraction effects on the doppler shift can be eliminated by using the transmission from two satellites. After four months of tracking the satellite by measuring the doppler shift of the satellite radio signal, the exact position of the satellite at any point in the orbit should be known. Using known orbital positions, ships and aircraft can then use satellite signals to make analogous computations to establish accurate position. Navigational fixes of 0.1 mile accuracy are

Ground Support and Tracking Stations The Navy Bureau of Weapons payload contractor provides a system of payload tracking stations which obtain information for precise orbit determination. These stations are located in Maryland, Texas, New Mexico, Newfoundland and Brazil. First and second stage tracking and telemetry, and second stage guidance will be provided by the facilities of the Atlantic Missile Range. A mobile downrange tracking station will receive telemetry data and tracking information during the last portion of the second stage Ablestar coast, re-ignition and second burn, payload spin-up and payload injection periods. This station was located in Erding, Germany, for the TRANSIT 1B flight, Punta Arenas, Chile, for the TRANSIT 2A and 3A and Pretoria, Union of South Africa for TRANSIT 3B.

Launch Schedule



Flight History

TRANSIT No.	Launch Date	Thor No.	Ablestar No.	Remarks
1A	*17 September*	*136*	—	*The three-stage vehicle was launched from Stand 17A at the Atlantic Missile Range. The payload was not injected into orbit, because the third stage motor failed to ignite.*
1B	*13 April*	*257*	*002*	*The Thor Ablestar boosted satellite was launched from Stand 17B at AMR. The satellite was placed into orbit. The Ablestar second stage (on its first flight test) fired, shut off, coasted, and then restarted in space.*
2A	*22 June*	*281*	*003*	*A dual payload, consisting of TRANSIT 2A plus GREB (which studied solar emissions), was placed in orbit by the Thor Ablestar vehicle. A propellant slosh problem, discovered in the second stage, has been corrected.*
3A	*30 November*	*283*	*006*	*TRANSIT 3A failed to achieve orbit when the first stage Thor shut down prematurely, after a failure in the main engine cutoff circuitry. Staging occurred and the second stage performed nominally until it was cut off and destroyed by Range Safety.*
3B	*21 February*	*313*	*007*	*TRANSIT 3B was launched with only partial success. The Ablestar stage failed to restart in space and the payloads did not separate. Although no definite cause has yet been determined, the counting device in the Ablestar programmer is considered the most probable cause of malfunction.*

Monthly Progress — TRANSIT Program

Transit 3B Flight Analysis

- TRANSIT 3B was launched from the Atlantic Missile Range Stand 17B at 1945:03 PST on 21 February. All functions were normal until the Ablestar restart and separation sequence was to occur. A malfunction in the Ablestar, probably in the programmer, prevented this from occurring. A highly degraded orbit resulted, as shown in Table I.

PARAMETER	ACTUAL	PROGRAMMED
Apogee, nautical miles	539	500
Perigee, nautical miles	91	500
Inclination Angle, degrees	28.38	28.5
Eccentricity	0.059	0

Table I. TRANSIT 3B Actual and Programmed Orbital Parameters

An analysis of the telemetry data indicates that the gyro reference assembly, motor electronics assembly and pneumatic control were operating throughout the entire period. Data indicates that main battery voltage, static inverter voltage, and frequency were nominal during flight. Calculations indicate that there were at least 74.6 pounds of fuel and 63 pounds of oxidizer residuals in the propellant tanks which precludes fuel depletion as a cause of failure to restart. Based on this data, the most probable cause of the malfunction was a failure in the Ablestar programmer.

- The Navy reports that the TRANSIT 3B payload operated in a partially successful manner. Payload antenna patterns received by ground stations indicate that in addition to still being attached to the Ablestar stage, it is tumbling. Doppler data is being received from the payload.

Technical Progress

TRANSIT 4A

- The booster vehicles for TRANSIT 4A are presently on schedule. The first stage THOR, serial number 315, is in Atlantic Missile Range Hangar M undergoing final assembly and checkout. The second stage Ablestar, serial number 008, completed its Flight Systems Test on 10 March and will be shipped to the Atlantic Missile Range on 24 April.

- The payload for TRANSIT 4A consists of three separate assemblies. The TRANSIT payload is the next step in the development of an operational navigation system. This will be the basic payload package. The INJUN satellite, a University of Iowa payload under the cognizance of Dr. Van Allen, will perform radiation measurements and is the second satellite. The third satellite is a Naval Research Laboratory (NRL) GREB with detectors to study solar emissions.

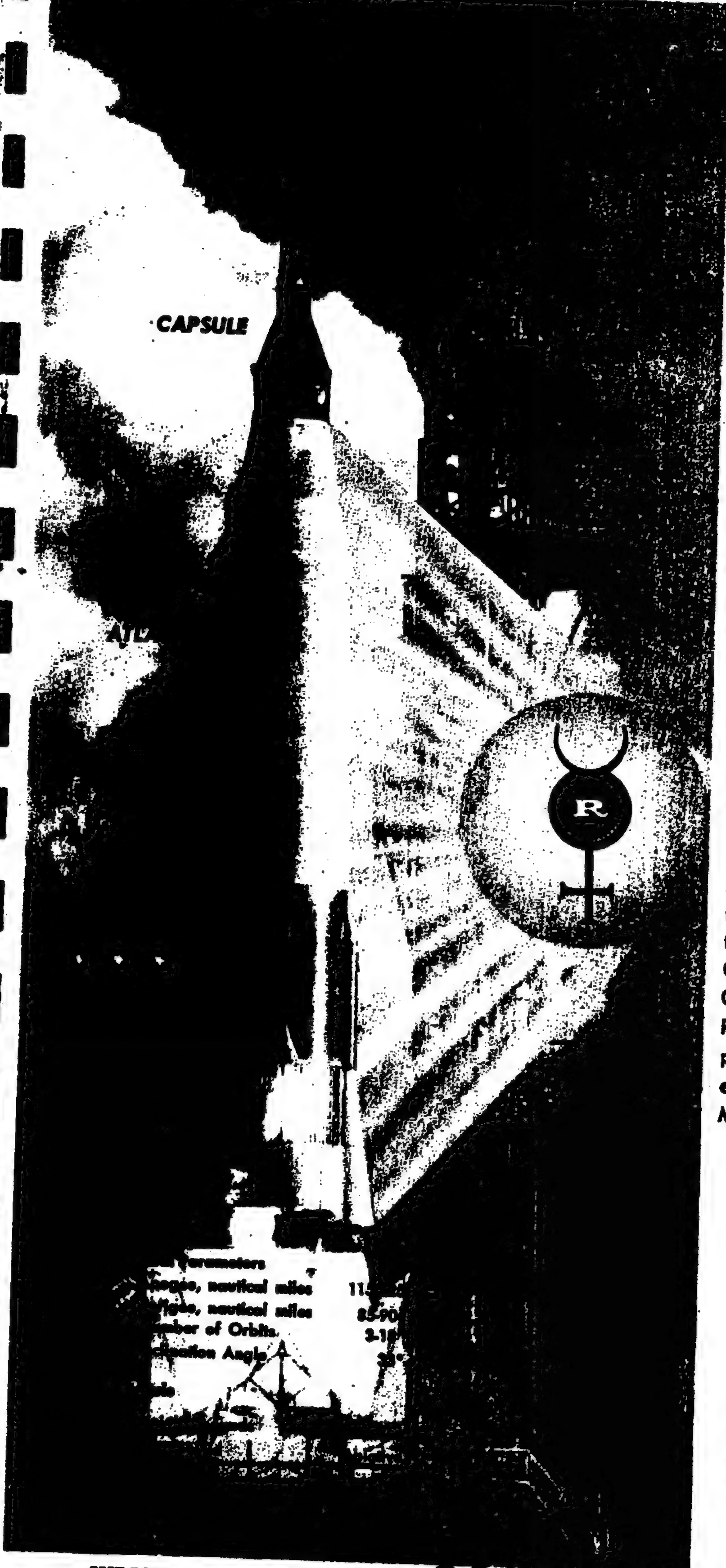
- At a Systems Coordination meeting held on 8 March 1961, BUWEPS stated that, because of an NRL payload problem, they desired a launch date slip from the week of 8 May to the week of 29 May. The launch is now scheduled for 1 June.

TRANSIT 4B

- Design work for incorporating the Bell Telephone Laboratories guidance equipment into the Ablestar stage has started at Aerojet General Corporation. This equipment will replace the Space Technology Laboratories transponder on subsequent TRANSIT vehicles. Studies have been initiated to determine the feasibility of using the 6594th Test Wing at Sunnyvale to accomplish the orbit determination task for TRANSIT 4B and subsequent vehicles.

TRANSIT 5A

- During the inspection of the TRANSIT 5A Ablestar propellant tank a pin hole leak was discovered. Space Systems Division/Aerospace/Aerojet have agreed upon a repair procedure that will not introduce any program slippage.



ERCURY

Project MERCURY represents the transitional threshold between this nation's cumulative achievements in space research and the beginning of actual space travel by man. The primary program objective is to place a manned satellite into orbit about the earth, and to effect a controlled re-entry and successful recovery of the man and capsule. Unmanned ICBM trajectory and near-orbital flights, and unmanned orbiting flights will be used to verify the effectiveness and reliability of an extensive research program prior to manned orbital flights. The program will be conducted over a period of approximately four years. The initial R & D flight test was accomplished successfully in September 1959. The total program accomplishment is under the direction of NASA. The primary responsibility of AFBMD to date consists of: (a) providing 15 ATLAS boosters modified in accordance with program objectives and pilot safety factors, and (b) determination of trajectories and the launching and control of vehicles through injection into orbit.

Major contractors participating in the AFBMD portion of this program include: Aerospace Corporation, systems engineering and technical direction; Convair-Astronautics, modified ATLAS boosters; GE/Burroughs, ATLAS guidance equipment; and Rocketdyne, engines. All of these companies also participate in launch operations, special studies and engineering efforts peculiar to meeting Project MERCURY requirements.

The MERCURY astronomical symbol (☿) with the "R" for Reliability will be attached to those components and missile end items which have been selected and accepted for use in boosters identified for Project MERCURY.

General Sequence of Events for MA-3 Flight

Following a four and one-quarter second hold, the vehicle will lift off from Atlantic Missile Range Stand 14. Upon General Electric guidance command the booster engine will shut down and separation will occur. Twenty seconds after longitudinal acceleration drops to 3g, the tower ring separation bolts fire and the escape tower will jettison. The sustainer and vernier engines will shut down upon ground guidance command and the capsule separation bolts will fire. When the longitudinal acceleration drops to 0.2g the posigrade rockets will be fired. After five seconds of damping the capsule will rotate and assume a retro attitude of 34°. The retro-rockets will be fired by ground command or by a backup timer. Sixty seconds after retro-fire the retro and posigrade package will be jettisoned and the capsule will assume a re-entry attitude. At 42,000 feet altitude the drogue parachute will be deployed. At 10,000 feet, the drogue parachute and antenna fairing will be jettisoned and the main parachute deployed. At impact the main parachute will be disconnected and the recovery aid deployed.

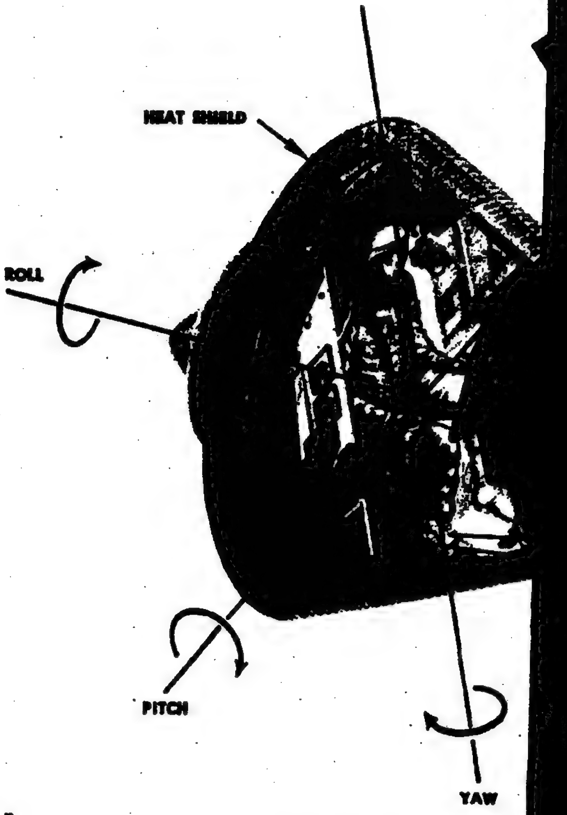
Space Syste

Space Systems

MERCURY Supp

- Fifteen modified ATL
- Launch complex and
- Systems development
- Studies and technical
- Safety program

Trajectory Outline



ℑivision

ƒ Functions

; "D" boosters

Jpport thru orbit insertion

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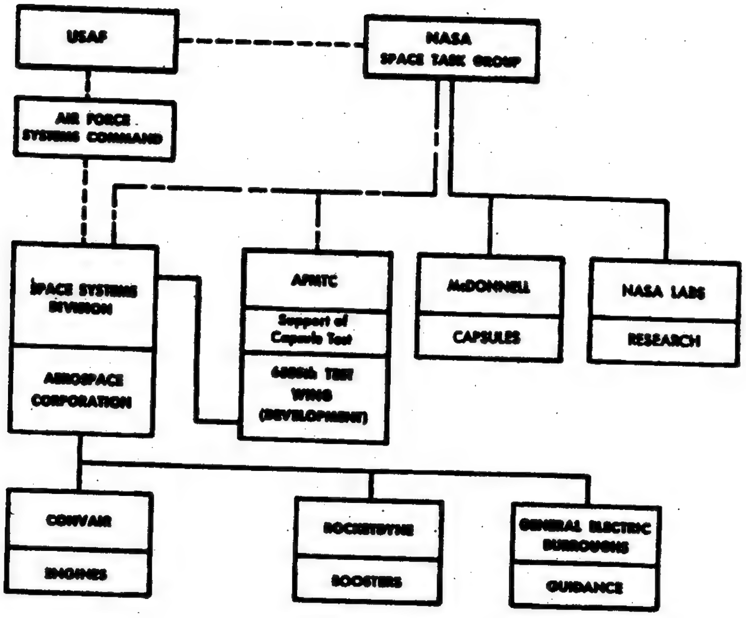


fŏr MA-3 Flight

RETRO ATTITUDE

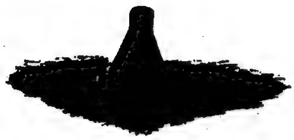
RETRO ROCKETS FIRE

RETRO and POSIGRADE ROCKETS JETTISONED

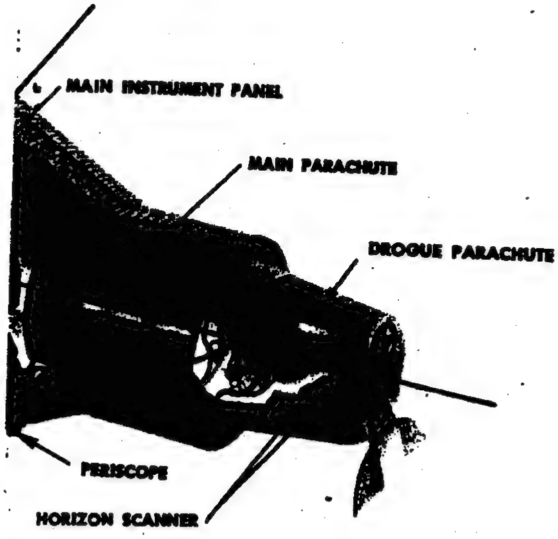
NORMAL ORBITAL FLIGHT

DROGUE PARACHUTE OPENS

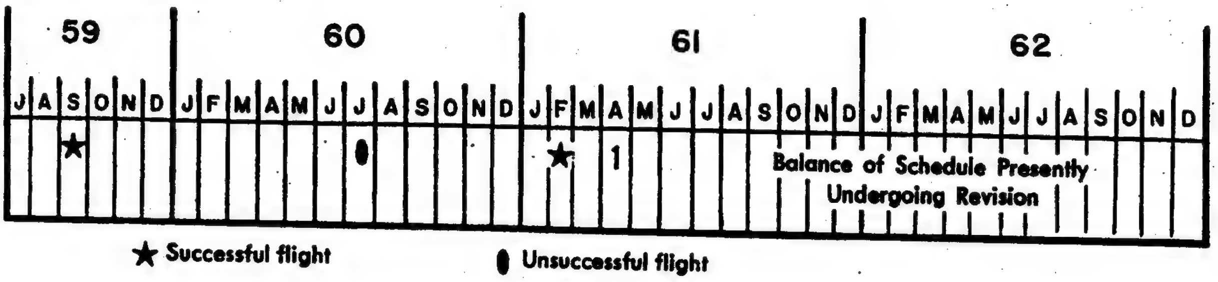
MAIN PARACHUTE DEPLOYED



IMPACT



Launch Schedule



Flight History

MERCURY Flight	Launch Date	ATLAS No.	Remarks
Big Joe I	9 September	10D	*Flight test objectives were achieved to such a high degree that a second, similar flight was cancelled. The capsule was recovered intact.*
MA-1	29 July	50D	*After one minute of normal flight guidance, rate, track lock, and telemetry were lost and the vehicle was destroyed. The exact cause of the malfunction has not been determined.*
MA-2	21 February	67D	*Test analyses have been completed and all booster and capsule test objectives were achieved.*

Monthly Progress — Project MERCURY

Flight Test Progress

MA-3 Flight

- ATLAS 100D, modified as required to support MERCURY, was delivered to the Atlantic Missile Range early in March. The ATLAS booster will be integrated with a NASA adaptor and capsule No. 8 to form an MA-3 vehicle. The launch of MA-3 is scheduled for 20 April.

- The Space Systems Division Pilot Safety Program for MERCURY/ATLAS boosters produced very favorable results on booster 100D. The Pilot Safety Program, basically a program to ensure a quality product, has been designed to increase in intensity so that peak performance will be realized on the launch immediately preceding the manned flight.

- The MA-3 mission is practically identical to that of orbital launches except that the capsule will be released for immediate re-entry just prior to reaching orbital altitude and velocity. The capsule will actually be released to match an insertion into orbit at an altitude of approximately 87 miles. Immediately after the capsule has positioned itself to the proper attitude, re-entry will be effected by firing the capsule retro rockets. Impact is planned to occur approximately 3,375 nautical miles downrange in the vicinity of the Canary Islands.

- A portion of the world-wide MERCURY tracking network will be used on this mission so that the command and control function can be operationally evaluated by NASA. Network stations to be used are the control center at Cape Canaveral, range stations at Bermuda, Atlantic Ocean Ship and the Grand Canary Islands, plus a tie-in of the space communications and computing center in the Washington, DC, area.

NASA Capsule MA-3 Flight Objectives

The flight objectives for the NASA capsule are:

1. Demonstrate the integrity of the capsule structure ablation shield and after body shingles for a normal re-entry from near-orbital conditions.
2. Evaluate the performance of the capsule systems for the entire flight.
3. Determine the capsule motions during a normal re-entry from near-orbital conditions.
4. Determine the capsule vibration environment during flight.

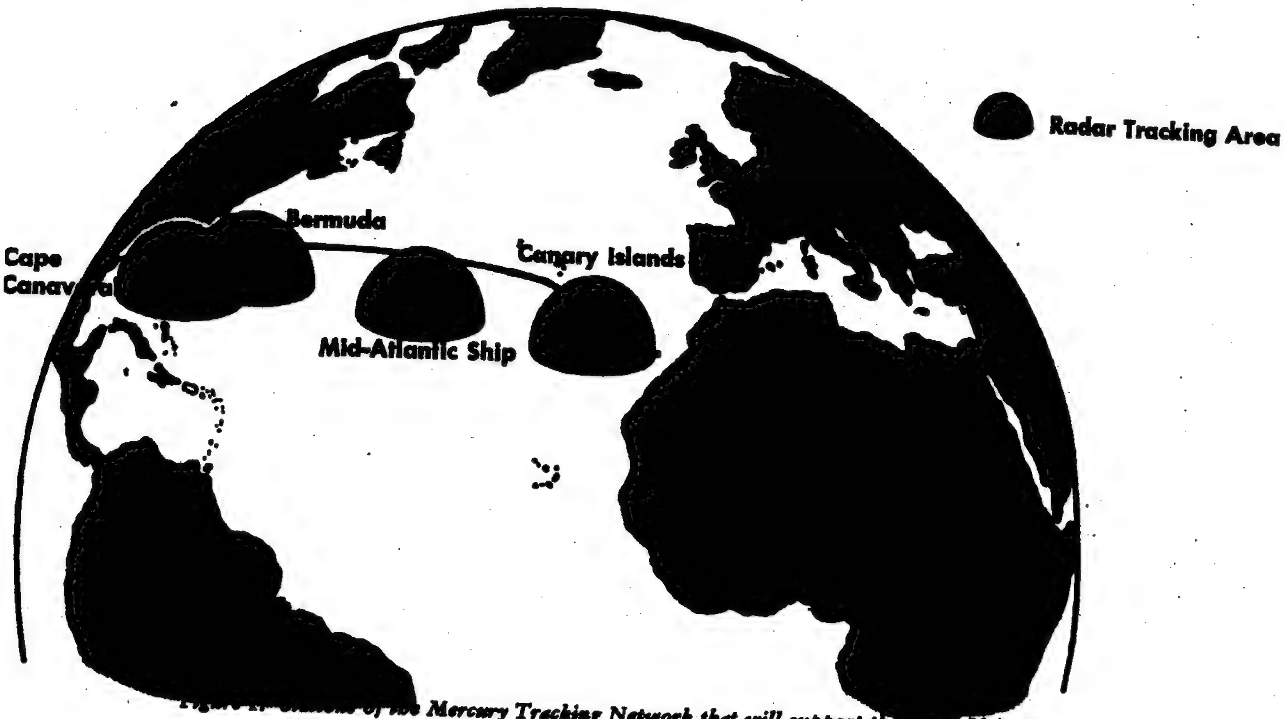


Figure 1. Stations of the Mercury Tracking Network that will support the April MA-3 flight.

5. Demonstrate the proposed operation of the ground command control equipment.

6. Evaluate the performance of the equipment and operational procedures used in establishing the launch trajectory, booster cutoff conditions and the prediction of landing points.

7. Evaluate the ground communications network and communication procedures.

8. Evaluate the performance of the network acquisition aids, the radar tracking system and the associated procedures.

9. Evaluate the telemetry-received system performance and the telemetry displays.

10. Evaluate the capsule recovery operations, as to equipment and procedures used for communications and for locating and recovering the capsule, for landing in the Atlantic Ocean along the MERCURY network.

11. Demonstrate the compatibility of the capsule escape system with the MERCURY/ATLAS system.

12. Evaluate and develop MERCURY network countdown and operational procedures.

ATLAS System MA-3 Flight Objectives

The flight objectives for the ATLAS booster are:

1. Determine the ability of the ATLAS booster to release the MERCURY capsule at the prescribed free flight insertion conditions defined by the guidance equations.

2. Determine the closed-loop performance of the Abort Sensing and Implementation System.

3. Evaluate the aerodynamic load, vibration characteristics, and structural integrity of the ATLAS liquid oxygen boil-off valve, tank dome, capsule adaptor and associated structures.

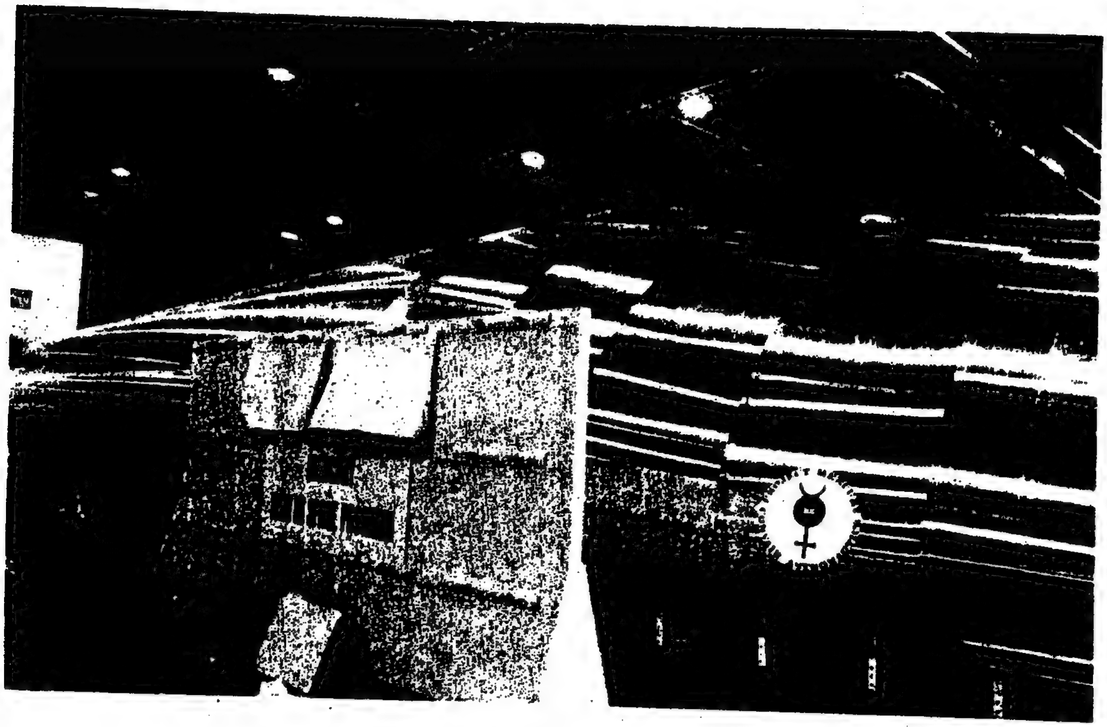
4. Determine the magnitude of the sustainer/vernier engine residual thrust after cutoff.

5. Obtain data on the repeatability of the performance of all ATLAS airborne and ground systems.

6. Evaluate the MERCURY/ATLAS vehicle with regard to engine start and potential causes of combustion instability.

Technical Progress

- Representatives of Aerospace Corporation, Convair-Astronautics and NASA Space Task Group met with Space Systems Division personnel on 28 March to establish a coordinated position on the flight performance of MA-2 and to determine instrumentation requirements for MA-3. The MA-2 test analysis is considered to be complete and all test objectives were met. The instrumentation for 100D will be similar to that used in 67D (MA-2). The major changes



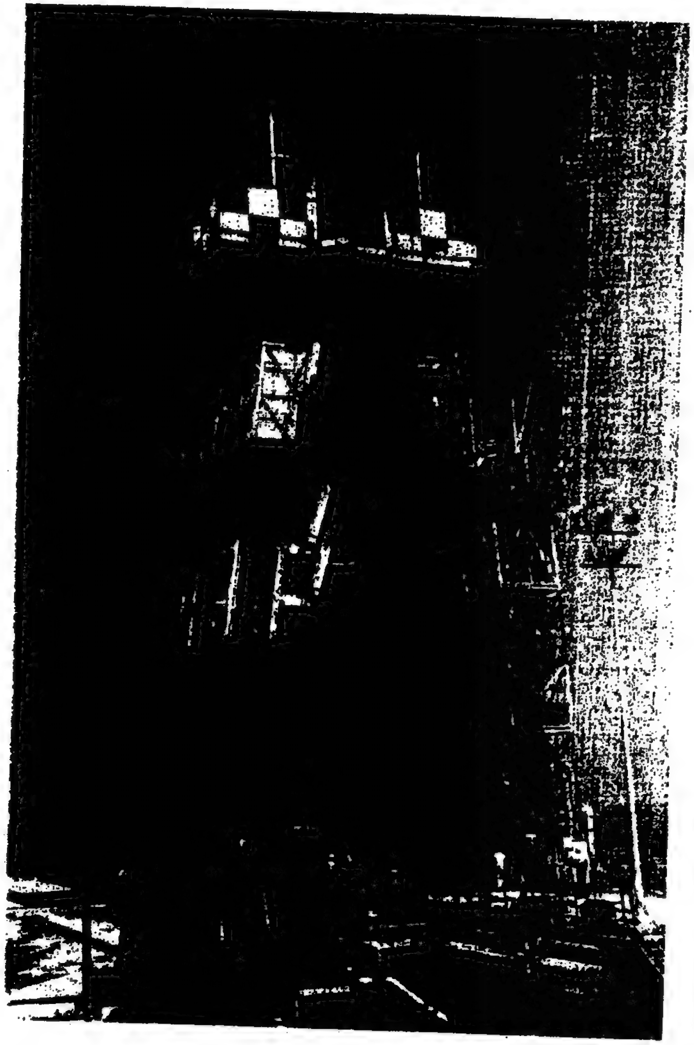
include the addition of thermocouples and the relocation of strain gages and accelerometers. One area of concern is that propellant slosh on MA-2 exceeded the anticipated values. Convair is certain that the problem can be satisfactorily controlled by changing the autopilot gains and responses for the MA-3 flight. Further study has been initiated on the feasibility of adding anti-slosh baffles in future MERCURY booster propellant tanks should the MA-3 flight indicate a requirement.

- The launch of MA-3 will utilize the first production "thick skin" ATLAS booster in support of MERCURY since the flight of Big Joe I (10D) in September 1959. Increased skin thickness in the construction of ATLAS liquid oxygen tanks for the MERCURY boosters resulted from engineering analysis of the MA-1 (thin skin booster, 50D) failure in July 1960. The tank for MA-2 was modified to incorporate a restraining band on the upper liquid oxygen tank.

- Convair has submitted a report on the use of "out-of-specification" stainless steel in some skin sections of certain ATLAS boosters. The strength of this non-standard steel, although out of tolerance, is still greater than the criteria used in booster structure computations. The report is being studied by Aerospace Corporation.

- MA-3 launch procedures are incorporating a 4½ second holddown time delay as did MA-2. This increased holddown period allows for increased flexibility in dealing with combustion instability should it occur. During the holddown time the system is protected by active rough combustion cutoff accelerometers which are deactivated when the booster is released. Combustion instability of any significance has usually occurred within this time period.

Figure 2. Final inspection (opposite) of ATLAS 100D (MA-3) which will be flown on 20 April. The Space System Division's Pilot Safety Program reliability seal is on the booster. This symbol is on all assemblies and indicates that they will become part of a "Man-in-Space" booster. Loading 100D into a C-133 aircraft (below) for its first flight. The wheels used for road transport must be removed to permit the booster and transporter to fit into the cargo aircraft. Erecting the booster on Atlantic Missile Range Stand 14. Final checkout and capsule mating will be performed prior to launch.

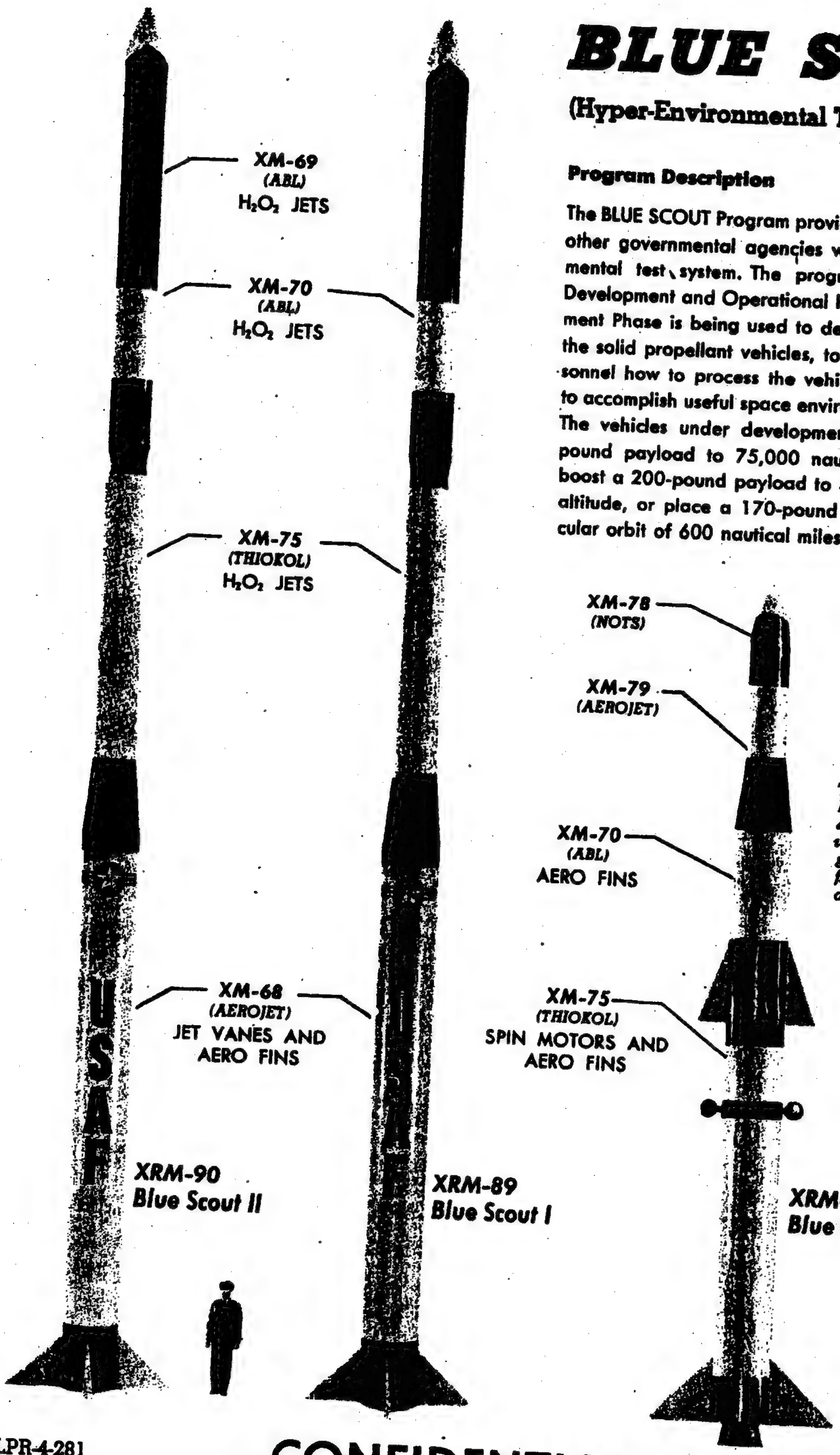


BLUE SCOUT

(Hyper-Environmental Test System)

Program Description

The BLUE SCOUT Program provides the Air Force and other governmental agencies with a hyper-environmental test system. The program is divided into Development and Operational Phases. The Development Phase is being used to develop and flight test the solid propellant vehicles, to train Air Force personnel how to process the vehicles for launch, and to accomplish useful space environment experiments. The vehicles under development will boost a 25-pound payload to 75,000 nautical miles altitude, boost a 200-pound payload to 4,000 nautical miles altitude, or place a 170-pound payload into a circular orbit of 600 nautical miles.



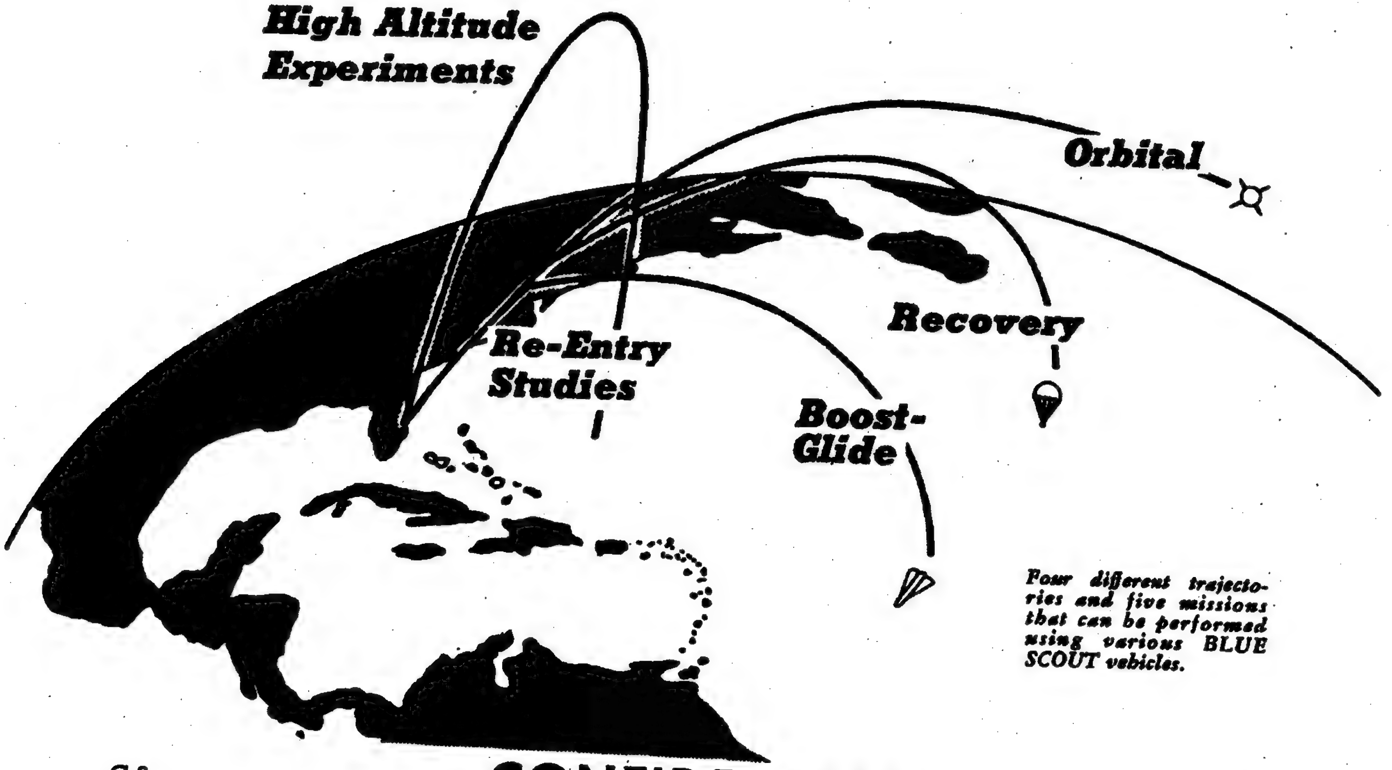
Three variations of BLUE SCOUT vehicles demonstrate the mission versatility of the program. The Air Force officer permits comparison of vehicle sizes.

Economy-Reliability-Versatility

ECONOMY in the Development Phase is being achieved by modifying the basic four-stage solid propellant NASA SCOUT vehicle to accomplish BLUE SCOUT program objectives. Modifications include provisions for stabilizing the fourth stage without spinning and using the vehicle in less than the full four-stage configuration. The development flight test program is being conducted by using existing assembly and checkout building and an existing launch complex. ECONOMY in the Operational Phase will be achieved by the use of this low-cost vehicle, launched by Air Force personnel, as a standard platform for supporting space systems, subsystems, and research projects. RELIABILITY will be obtained by a twelve vehicle BLUE SCOUT development flight test program, in addition to the eight vehicle NASA SCOUT development flight test program, plus a continuous quality control and improvement program throughout the life of the system. VERSATILITY will be achieved by having a series of configurations capable of being readily adapted to a wide range of payload variations, and capable of being flown in several combinations of four stages or less. This VERSATILITY results in the following flight capabilities: vertical probes having a wide variance of payload weight/altitude combinations; boost-glide trajectories; ballistic missile trajectories; downward boosted, high-speed re-entry profiles, and orbital flights.

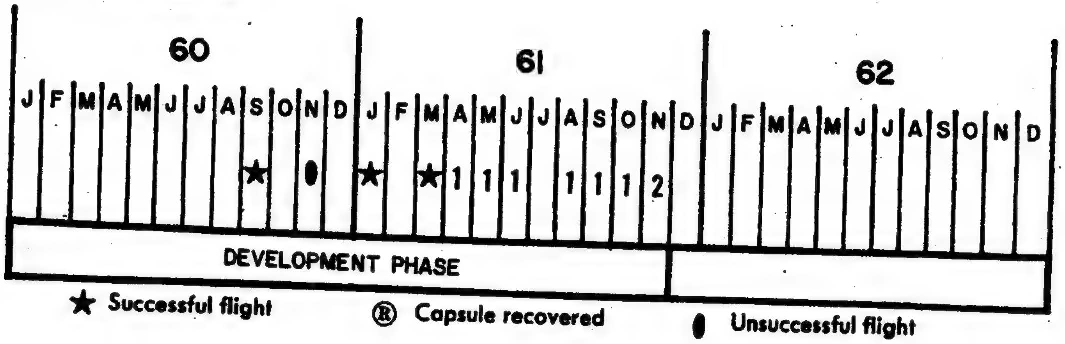
Program Management

An abbreviated development plan, covering the development phase only, was approved on 9 January 1959. This plan gave AFBMD management responsibility. In June 1959, Aeronutronic Division of the Ford Motor Company was chosen through normal competitive bidding as the Payload, Test and Systems Integration Contractor. The procurement of vehicle components and associated support equipment, modified to meet BLUE SCOUT requirements, is being made through NASA, rather than direct procurement from the SCOUT contractors. Atlantic Missile Range launch complex 18 and an existing assembly building are being used for the development phase of the program. The 6555th Test Wing (Dev) manages the development test program at the Atlantic Missile Range and provides the Air Force personnel who are being trained to assume the vehicle processing, launch and evaluation tasks. An all-military operational capability will be developed from this group.



Four different trajectories and five missions that can be performed using various BLUE SCOUT vehicles.

Launch Schedule



Flight History

Blue Scout	Launch Date	Type of Flight*	Type Designation	Remarks
D1	21 September	A	XRM-91	*Telemetry was lost prior to fourth stage burnout. The trajectory to this point was as planned and the payload probably reached an altitude of 14,000 n.m. All of the primary (vehicle) objectives were accomplished; none of the secondary (payload) objectives were achieved.*
D2	8 November	A	XRM-91	*A second stage motor failure occurred at T plus 60 seconds. The vehicle impacted approximately 240 n.m. downrange.*
D3	7 January	A&C	XRM-89	*The 392-pound payload was successfully launched to an apogee of 960 nautical miles and impacted 1025 nautical miles downrange (175 nautical miles short of that programmed). The recovery capsule survived re-entry but was not recovered. Except for this, all primary objectives were achieved as were the majority of secondary objectives.*
D4	3 March	A	XRM-90	*The 172-pound payload was successfully launched to an apogee of 1,380 nautical miles and impacted 1,720 nautical miles downrange. The test was completely successful. All primary and secondary objectives were achieved. Valuable payload experiment data were obtained.*

***Type of Flight**

A — High Altitude Experiments	C — Recovery	E — Boost-Glide
B — Re-Entry Study	D — Orbital	

Monthly Progress — BLUE SCOUT

Program Administration

- The part of the follow-on program which is in support of the applied research function is being defined by the Air Force Office of Aerospace Research, under the Research Probes Program. The number of launches to be accomplished in support of this activity will depend on the funding ultimately provided in the final FY 62 budget.

- Other areas are being investigated for possible BLUE SCOUT support under the follow-on program

1. A plan is being prepared for a cloud cover monitoring satellite with Tiros components, launched by a BLUE SCOUT vehicle for possible support of future SAMOS operations.

2. Plans are being formulated for BLUE SCOUT support of the ASSET Program, which is under the cognizance of the Air Force Aeronautical Systems Division (ASD). Under this program, boost glide models, designed and fabricated by McDonnell Aircraft, will be launched into appropriate boost-glide trajectory profiles to test structures for advanced boost-glide vehicles.

3. Support is being furnished to the Beanstalk Program, which may use BLUE SCOUT Jr. vehicles to boost communication payloads into probe trajectories to satisfy a SAC requirement for emergency positive control of remotely located aircraft.

Flight Test Progress

- The fourth BLUE SCOUT vehicle (D-4) was launched from the Atlantic Missile Range at 1602Z on 3 March. The vehicle boosted a 172-pound Air Force Special Weapons Center payload to an altitude of approximately 1380 nautical miles on a

Figure 3. Members of the BLUE SCOUT assembly, checkout and launch team. Having a "Blue Suit" launch capability is one of the reasons for the ECONOMY realized in the BLUE SCOUT Program. Air Force technicians (right) pumping peroxide into the BLUE SCOUT II vehicle.

probe trajectory. All primary and secondary test objectives were met and valuable radiation measurement information was obtained by the six payload experiments. The success of this mission brings the record for combined NASA-Air Force launches of guided Scout type vehicles to five successes out of six attempts.

- The launch of the fifth BLUE SCOUT vehicle (D-5) is scheduled for 13 April. A guided BLUE SCOUT II (XRM-90) vehicle will boost a 365-pound payload to an apogee of 1075 nautical miles with impact planned for 1437 nautical miles downrange. The payload contains seven Cambridge Research Laboratory and AFASD experiments which will make geodetic and radiation measurements. The vehicle will contain a 95-pound data recovery capsule. Checkout and assembly of this four-stage vehicle is proceeding on schedule at the Atlantic Missile Range.

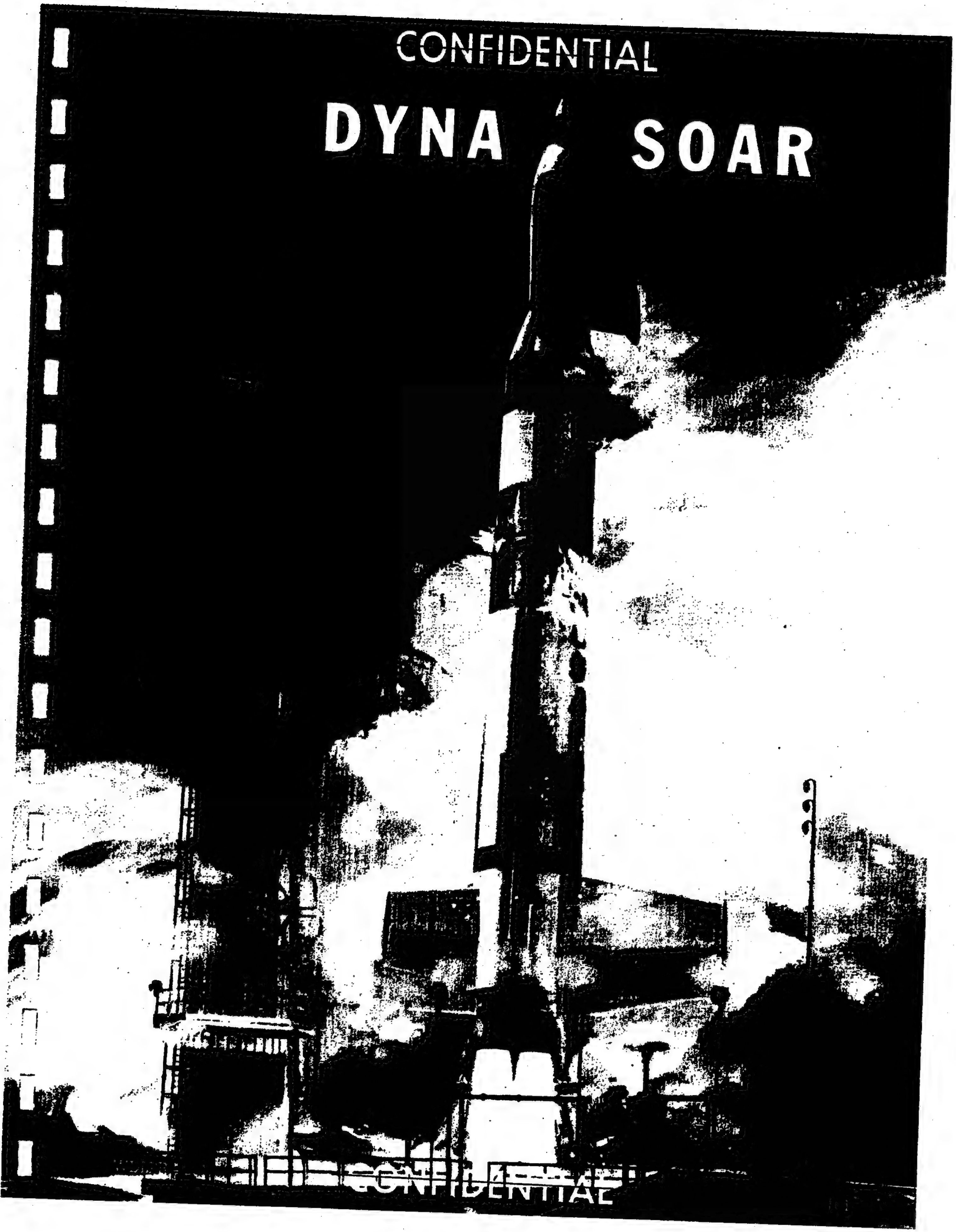
Facilities

- Design effort has been temporarily deferred on the facilities for support of the follow-on program. Space Systems Division has advised Headquarters, Air Force Systems Command that construction funds for these Atlantic Missile Range Operational phase facilities must be provided by June 1961, or a delay in the follow-on flight program will result. The missile assembly facility now in use at the Atlantic Missile Range is being condemned by AFMTC.

Figure 4. Two photographs of the same area, prior to launch (left) and after launch (above). The block house for Atlantic Missile Range Complex 18 is the dark mound on the left of the XRM-90 vehicle. The launcher, mast, and gantry are hidden in smoke as the BLUE SCOUT II is launched. This 3 March flight was the third success of the four flights made to date.

CONFIDENTIAL

DYNA SOAR

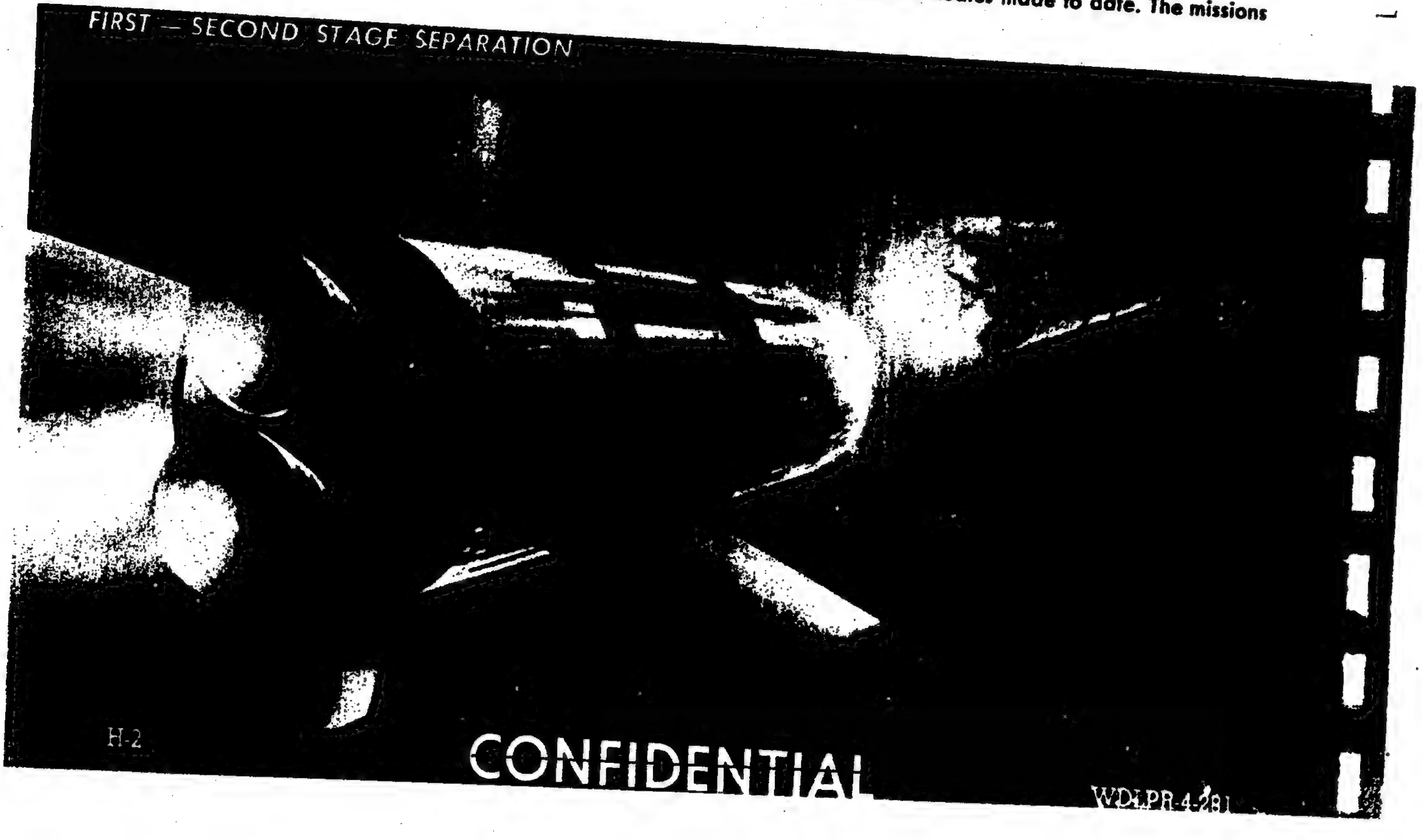


CONFIDENTIAL

Program History—Competition for the DYNA SOAR study contract was initiated in 1958 and resulted in the Boeing Airplane Company and the Martin Company being awarded the follow-on contract to more fully define their proposed approaches. In November 1959, following review and evaluation of the Boeing/Martin detailed studies by a Source Selection Board, it was announced that Boeing had been selected as the glider and system integration prime contractor, with Martin furnishing modified TITAN ICBM's for booster support. The determinations and findings were elaborated on by Dr. Charyk to require a study program, Phase Alpha, with objectives of reaffirming the proposed glider design and indicating any changes required to that design. In April 1960, the Phase Alpha study was completed and the results were presented to the Department of Defense. On 9 May, formal approval of the DYNA SOAR Step I Program was received by AFBMD/BMC from WADD/ASC.

During the period covering program go-ahead to the end of CY 1960, efforts on the program were concentrated on design refinements to TITAN I and possible increased booster performance to accomplish program objectives. Studies on booster capabilities revealed many favorable factors on cost, time and expanded objectives by use of the XSM-68B (TITAN II) as the booster. Results of these studies were presented to Headquarters USAF and the Department of Defense. Headquarters USAF directed use of TITAN II as the SYSTEM 620 DYNA SOAR Step I Booster. Formal direction to use TITAN II was received by AFBMD/BMC from WADD/ASC on 13 January 1961.

Program Objectives—The DYNA SOAR Program will explore the possibilities of manned flight in the hypersonic and orbital realms. The program will proceed in three major steps from a research and test phase to an operational military system. In Step I, a full scale, minimum sized manned glider will be developed. A modified version of the TITAN II ICBM will boost the glider into hypersonic flight at velocities up to 22,000 ft/sec and permit conventional landing at a predetermined site. In Step II the glider will be tested, using a more powerful booster to achieve orbital velocities. This phase may be expanded into an interim operational weapon system providing all-weather reconnaissance and satellite interceptor capabilities. The objectives of Step II are to test vehicle performance between 22,000 ft/sec and orbital velocities; and to gather re-entry data from various orbits. Step III will provide an operational weapon system with a vehicle that will operate primarily in a hypersonic glide, be able to maneuver within the atmosphere, and be able to make a conventional landing at a predetermined site. The capability of DYNA SOAR type systems to perform these programmed missions appears attractive as a result of studies made to date. The missions



FIRST — SECOND STAGE SEPARATION

under study are: reconnaissance (manned and unmanned); air and space defense; strategic bombardment and logistics support. Manned and unmanned versions are being considered where applicable.

Flight Program — Step I includes twenty air-launched, manned flights with the glider being dropped from a B-52. Sixteen booster-launched flights will follow; flights 1 and 2 are designated as unmanned flights. If all significant flight objectives are achieved, the third flight will be manned. Flights 3 and 4 have been programmed as backup flights in the event that flights 1 and/or 2 do not achieve program objectives. The frequency is five launches at two-month intervals and eleven launches at six-week intervals. The range from Wendover AFB, Utah, to Edwards AFB is adequately instrumented for the tracking and telemetry required during the air-launched tests of the DYNA SOAR glider. Instrumentation sites for the AMR launches will be located at Cape Canaveral, San Salvador, Mayaguana, Antigua, Santa Lucia, and Fortaleza. Instrumentation, tracking, and recovery ships will be provided to supply additional support for the AMR launches. Landing facilities will be provided at Fortaleza, Brazil; Santa Lucia, Lesser Antilles; and Mayaguana, Bahama Islands.

Program Responsibilities — Steps I and II of the DYNA SOAR Program are to be conducted by the USAF with NASA participation. USAF will provide program management and technical direction, with WADD having responsibility for over-all system management.

AFBMD is responsible for the booster, special airborne systems, Aerospace Ground Equipment (AGE), and booster requirements of the launch complex. WADD will have responsibility for glider and subsystem development. NASA will provide technical support in the design and operation of the glider in obtaining basic aeronautical and space design information.

Technical Approach—AFBMD's technical approach to meet the objectives of the program are:

1. Modifying a TITAN II ICBM by adding stabilizing fins; strengthening the holddown and skirt area, intertank and interstage sections; redesigning the guidance bay; incorporating a malfunction detection system.

2. Modifying the XLR 87-AJ-5 and XLR 91-AJ-5 rocket engines to obtain structural compatibility with the modified booster; include malfunction detection system shutdown and fail safe systems.

3. Modification of an AMR launch pad.

4. Provide an integrated launch countdown.

SECOND STAGE — GLIDER SEPARATION

Monthly Progress – DYNA SOAR Program

Program Administration

- On 14 March, executives from NASA, contractors, and Air Force commands participating in the DYNA SOAR Program attended the second DYNA SOAR Executive Council meeting at the Martin Company, Baltimore. The Space Systems Division was represented by the Vice Commander and the DYNA SOAR Booster Program manager. Program managers from government agencies and industrial contractors participating in the DYNA SOAR Program attended the 15 March Management Council meeting at Martin-Baltimore. The primary purpose of these meetings is to evaluate program progress and to resolve policy/management problems. On 24 March 1961, negotiations were completed with the Baltimore Division of The Martin Company on the modified TITAN II booster. The resulting contract includes the R&D effort from May 1960 to September 1961 culminating with the mock-up inspection.

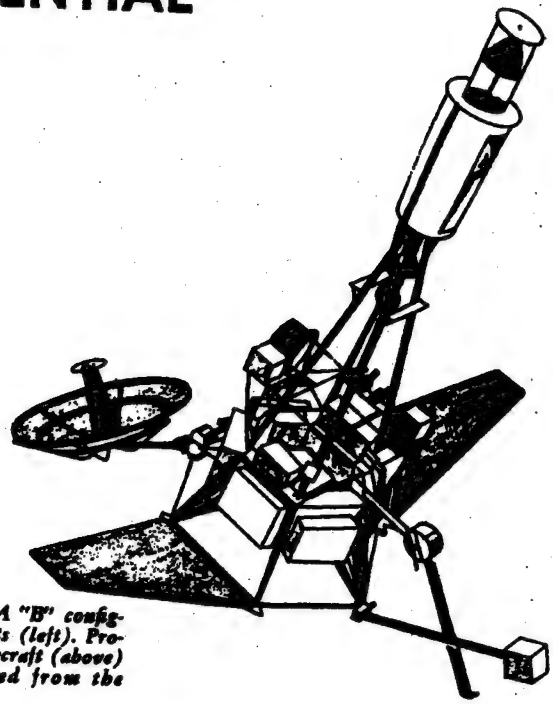
Technical Progress

- On 13 March, approval was received from the Aeronautical Systems Division to use the General Electric Mod III G equipment for booster radio guidance. This decision was in accord with recommendations to ASD by joint SSD/Aerospace team on 8 February 1961.

- Booster ionization and telemetry meetings were held at the Space Systems Division during March for the purpose of exchanging data. Representatives from Boeing, Martin, Avco, Stanford Research Institute, NASA, ASD and SSD attended. The results of these meetings will be used to determine the desirability of utilizing Super High Frequency (SHF) for booster telemetry and also the type of equipment to be used.

- A joint meeting of MERCURY and DYNA SOAR personnel was held at SSD on 1 March to continue the data exchange on the respective pilot safety systems. Much valuable information was obtained from MERCURY experience which will be used in designing and testing the DYNA SOAR Malfunction Detection System.

NASA AGENA "B" PROGRAM



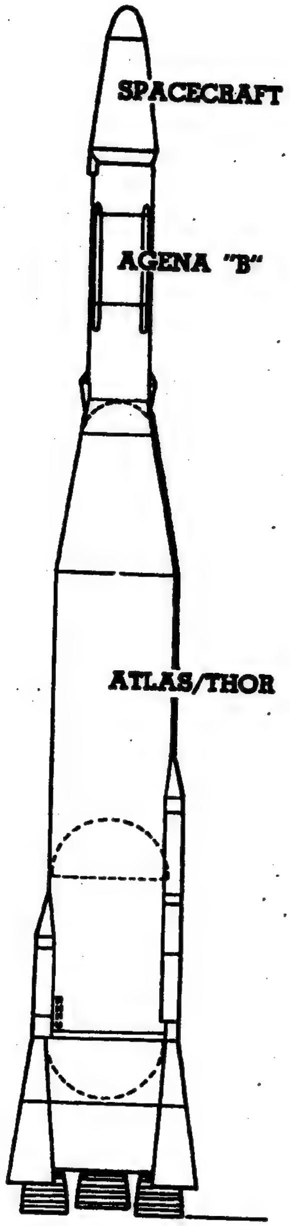


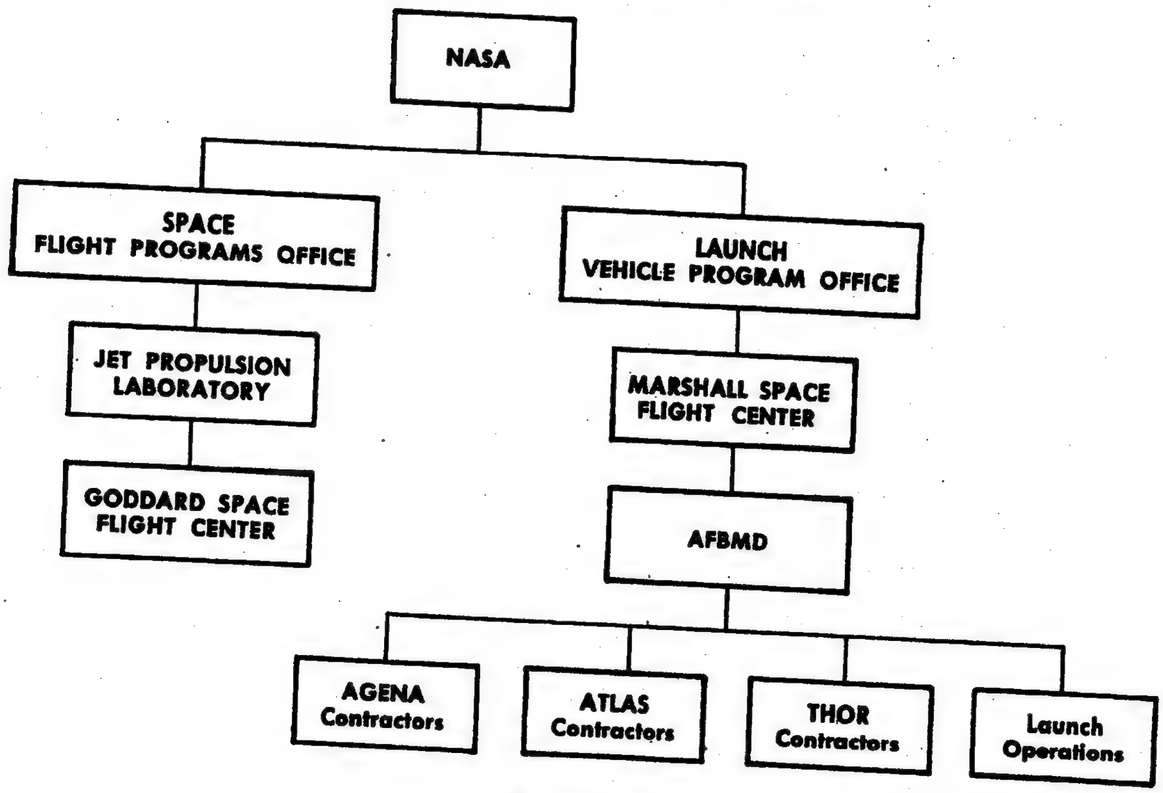
Figure 1. NASA AGENA "B" configuration for Ranger flights (left). Proposed Ranger lunar spacecraft (above) which will be launched from the Atlantic Missile Range.

Program Objectives—The basic objective of the NASA AGENA "B" Program is to place a separable spacecraft on a prescribed ballistic trajectory or into lunar orbit to gather scientific information and data. The program will first demonstrate the capability of jettisoning the spacecraft shroud and separating the spacecraft from the AGENA "B" vehicle. The program will also develop and demonstrate the capability of the AGENA "B" retro system to retard the second stage. To achieve these objectives the NASA will use the background and experience gained by the USAF in their Satellite System programs in terms of AGENA engineering, procedures and launch operations.

Flight Program—Although it is intended that this program will continue for several years beyond 1962, only the launches through 1962 are firm. The current schedule is as follows:

Launch Date		Booster	Mission
July	1961	ATLAS	Lunar Test Vehicle
October	1961	ATLAS	Lunar Test Vehicle
January	1962	ATLAS	Lunar Impact
March	1962	THOR	Scientific Satellite
April	1962	ATLAS	Lunar Impact
April	1962	THOR	Communication Satellite
June	1962	ATLAS	Lunar Impact
June	1962	THOR	Meteorological Satellite
September	1962	THOR	Backup

Note: Lunar flights will be launched from the Atlantic Missile Range; all others will be made from Vandenberg Air Force Base.


NASA
SPACE FLIGHT PROGRAMS OFFICE
LAUNCH VEHICLE PROGRAM OFFICE
JET PROPULSION LABORATORY
MARSHALL SPACE FLIGHT CENTER
GODDARD SPACE FLIGHT CENTER
AFBMD
AGENA Contractors
ATLAS Contractors
THOR Contractors
Launch Operations

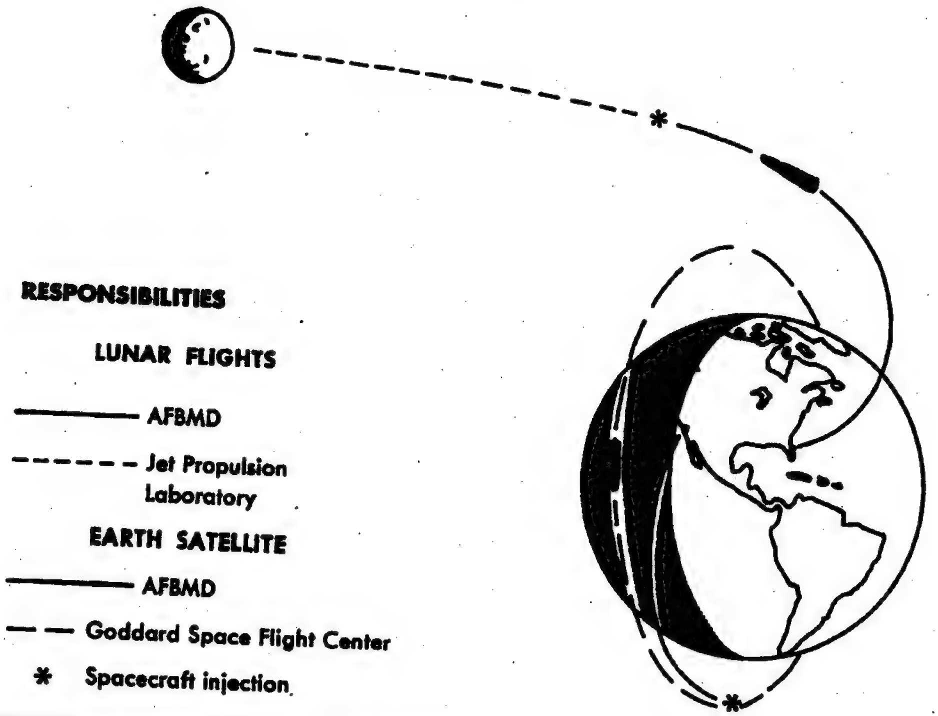
NASA AGENA "B" Project Organization Chart

Program Responsibilities—Under NASA Order No. S4601-G the Air Force is supporting the NASA AGENA "B" Program. This will permit NASA to take full advantage of the technical and operational background and experience developed by the Air Force in space booster projects; permit contractors to discharge their contractual obligations with NASA and USAF utilizing already established management relationships, insofar as practicable; and provide NASA the benefits of contract administration services and procedures already established for USAF programs employing the same basic vehicles as those scheduled for this program.

Program Status—AFBMD has taken the following action to support the NASA AGENA "B" Program:

1. Awarded Lockheed Missile and Space Division a contract (letter Contract -592) dated 12 April 1960) for the procurement of modified AGENA "B" second stage vehicles, jettisonable spacecraft shrouds, overall systems engineering and vehicle launch.
2. Issued a contract change notice to Convair Astronautics for five modified ATLAS "D" boosters to support the lunar flights.
3. Allocated eight THOR boosters to NASA.
4. Initiated contractual action with General Electric and Bell Telephone Laboratories for guidance systems to be used on the ATLAS and THOR boosters, respectively.
5. Published the program requirements document setting forth the requirements to be imposed upon the Atlantic Missile Range to support this program.
6. The Space System Development Plan for the NASA AGENA "B" Program was approved on 12 August. Headquarters ARDC is responsible for distribution of the Development Plan to appropriate NASA organizations.

NASA AGENA "B" Program Flights



Monthly Progress — NASA AGENA "B"

Program Administration

- The work statement in support of the -592 contract with Lockheed Missiles and Space Division was amended to include the Spacecraft support effort for the Scientific Satellite (S-27), Communications Satellite and the back-up vehicle which may support either of these missions. A revised work statement was submitted to the Space Systems Division and will be incorporated in the contract late in April.

Technical Progress

Ranger Lunar Program

- The System Test Complex at Lockheed Sunnyvale was completed on 3 March and AGENA "B" vehicle 6001 began integrating systems tests on 6 March. Two discrepancies were discovered, one on the C-band beacon and another in the velocity meter. These discrepancies were corrected and a completely successful system run was accomplished on 25 March.

- The radio frequency interference tests were achieved on 27 March. These tests are designed to insure that the transmitting and receiving equipment on the ATLAS AGENA and RANGER Spacecraft is compatible. These tests were completed on 31 March and the preliminary data indicates that there is no interference between these systems. AGENA "B" booster 6001 is scheduled for delivery to Santa Cruz Test Base on 17 April for static test firings prior to shipment to the Atlantic Missile Range.

- Modification of Pad 12 at the Atlantic Missile Range is proceeding satisfactorily with all launch control equipment available for installation. Several items of aerospace ground equipment required to support the stand activities are considered critical; however, it is anticipated that this equipment will be available to support the scheduled launch date.

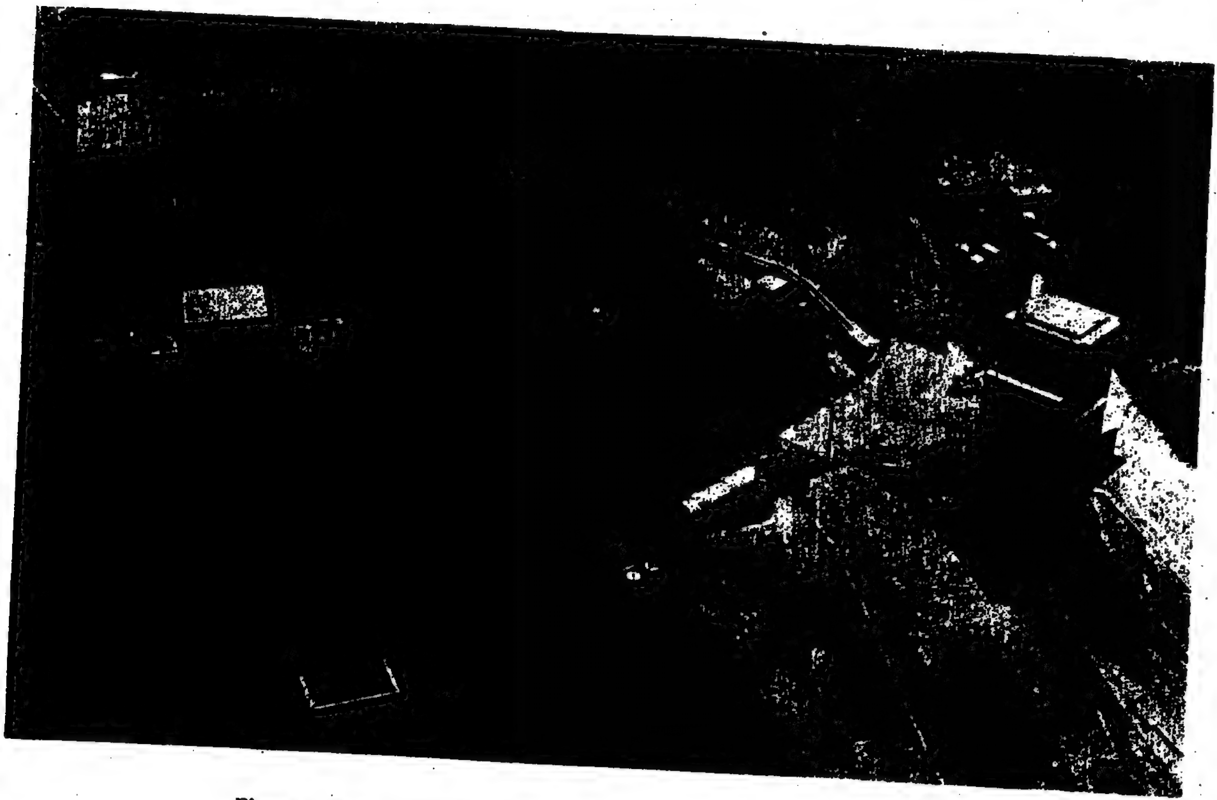


Figure 2. Santa Cruz Test Base Stand No. 3, formerly used in the Polaris Program, is being modified and will be used for hot firings of the NASA AGENA "A" Program second stage vehicles. The modification will be completed late in April. The building in the upper left is the blockhouse, below it is the gas storage area. The pattern on the hillside around the test stand is caused by concrete filled bags which have been sprayed with concrete to prevent soil erosion.

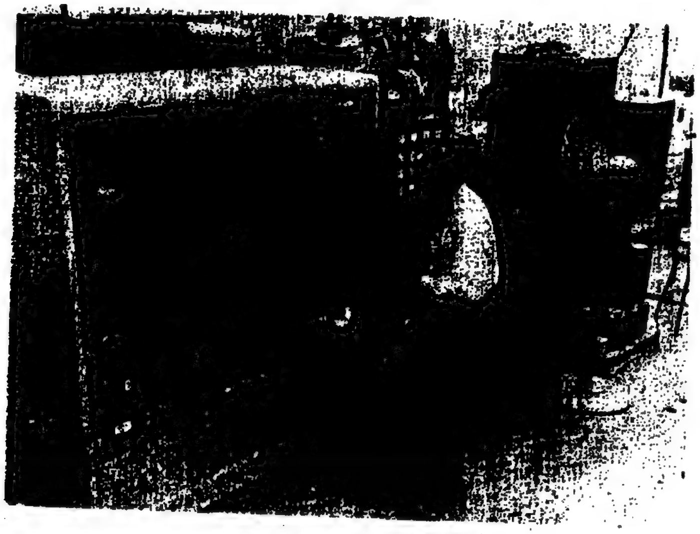
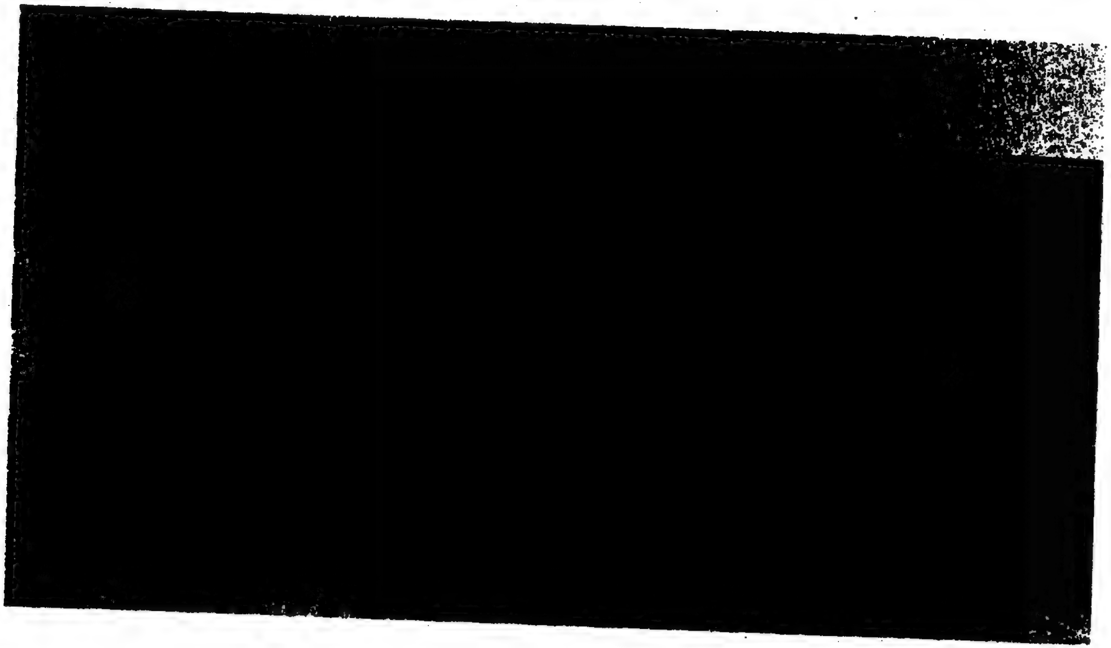


Figure 3. A portion of the consoles and recorders (above) used in conducting the recent R-F Payload-AGENA compatibility tests. The antennas (left) used during the tests. An overall view of the test setup used during the tests. An R-F shield was constructed above the antennas and vehicles.



- The results of the range safety study prepared by Lockheed and the Siegler Corporation was presented to range safety personnel at the Atlantic Missile Range. A waiver was requested for incorporation of a command destruct system in the AGENA "B" vehicle. Range safety representatives are expected to announce their decision by 1 April.

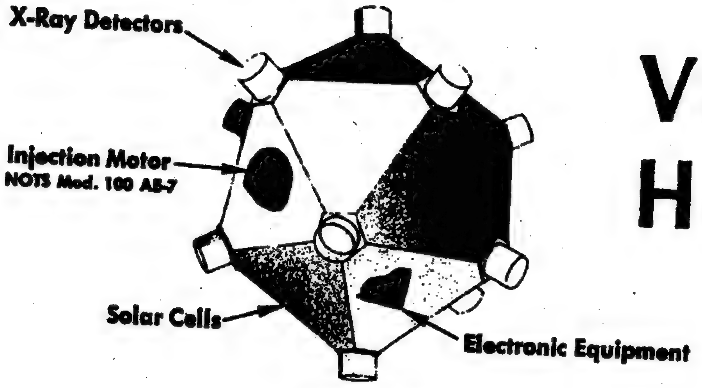
- The possibility of using RJ-1 fuel in the Ranger Program ATLAS boosters is being considered by Space Systems Division and Marshall Space Flight Center, Convair-Astronautics, and Rocketdyne have presented their analysis of the problems of changing to this fuel. The final decision is pending the static firing tests on the ATLAS engines at the Rocketdyne test facility. Maximum effort is being expended to have these tests completed and the results analyzed in time to incorporate this change for the first Ranger flight.

- ATLAS 111D is in final checkout at the Convair-Astronautic facilities.

Scientific Satellite Program

- The configuration proposed by Lockheed Sunnyvale for the Scientific Satellite launch in March 1962 was presented to Space Systems Division personnel on 17 March. The Spacecraft support hardware which includes an RF transparent clamshell shroud and a spin table adapter has been subcontracted to Douglas Aircraft Company. It is planned to design the shroud for the S-27 mission so that it can be used on the NIMBUS Program without modification.

VELA HOTEL



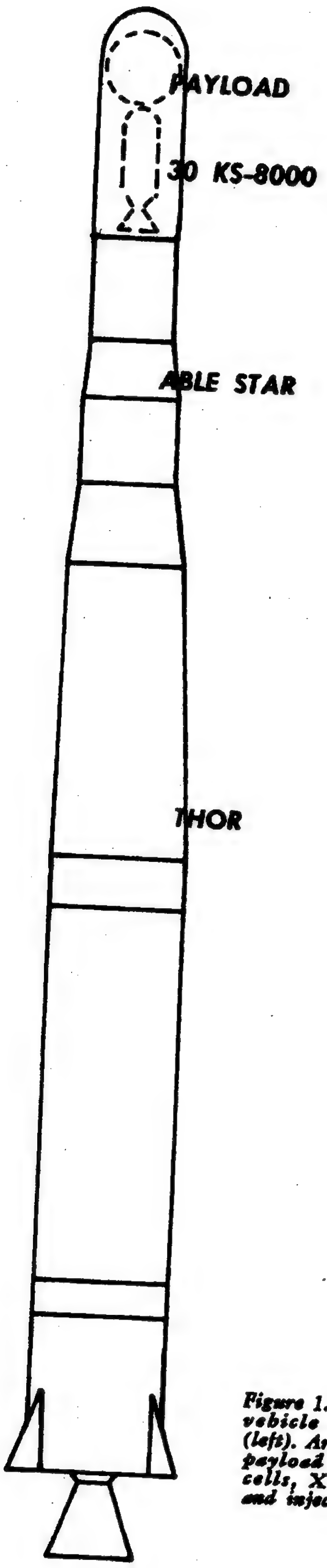


Figure 1. VELA HOTEL vehicle configuration (left). Artist's concept of payload showing solar cells, X-ray detectors and injection motor.

Program Objectives

- The objective of the VELA HOTEL Project is to conduct a research and development program including experiments and prototype testing to gain information which will lead to the definition of an operational space-based system for high altitude nuclear detonation detection.

Program History

- The Panofsky Panel on High Altitude Detection, reporting to the President's Scientific Advisory Committee, made several recommendations with respect to research and development work which should be accomplished in order to increase basic understanding of the physical mechanisms involved. The Department of Defense agreed to assume over-all responsibility with Atomic Energy Commission support in the high-altitude detection area. Further, it was agreed that the AEC would undertake laboratory development of the nuclear detection instrumentation and that the portion of the effort concerning measurements of natural radiations in space should be implemented jointly by the DOD and the NASA.
- Within the Department of Defense, the Advanced Research Projects Agency was assigned the management responsibility for Project VELA on 22 September 1959. On 18 September 1959, ARPA issued Order Number 102-60 to ARDC for a study and evaluation of the technical and operational factors associated with the detection of high-altitude nuclear detonations. The initial results were used in October 1959 to provide the State Department with supporting technical data for the United States delegation at the Geneva conference. Amendment No. 1 to the original ARPA Order directed ARDC to extend and refine the original study. It was subsequently requested that a joint working group including ARDC, AEC and NASA representatives, chaired by ARDC, be established. The mission of the Technical Working Group was to recommend a research and development program which would investigate the concept of nuclear detonation detection from satellites. To facilitate conducting the work involved,

the Joint Working Group formed subcommittees for payload, space boosters, and communications and control.

Program Concept

- The program recommended by the Joint Working Group included placing in orbit three full-scale experimental satellites from each of nine ATLAS/AGENA launches. These launches would start two years after program initiation. The satellites were to be placed in orbits outside the natural radiation belts of the earth and were to contain X-ray, gamma ray and neutron detectors. Because of the high cost, the research program was not approved; instead a "limited scope" program was authorized by ARPA.

- With its funds, AEC is initiating a piggyback flight program aboard Rangers (Lunar probes), NASA Scouts and Mariners (Venus probes). Some low-altitude experimentation and a few long-life satellites will be required in addition to these AEC flights. Therefore, additional ARDC/AEC programs will be implemented as follows:

1. Several DISCOVERER piggyback low-altitude polar orbit flights which obtain background radiation data below the Van Allen belts.
2. A limited number of small long-life satellites in elliptic orbits with apogees of about 50,000 nautical miles.

- The DISCOVERER piggyback flights as proposed will carry Lawrence Radiation Laboratory experiments consisting of X-ray, gamma ray and neutron detectors, PENG (proton-electron-neutron-gamma ray) detectors and solid state spectrometers.

- The small satellites as now envisioned will be launched into an orbit having a 200 nautical mile perigee and a 50,000 nautical mile apogee. A small injection motor contained in the satellite will be fired at apogee, thus raising the perigee to approximately 35,000 nautical miles. The instrumentation planned for these small satellites is of a pre-prototype design and will consist of X-ray, gamma ray and neutron detectors, Geiger counters, electrostatic analyzer and a differential detector system. Launches of the THOR boosted vehicles are tentatively scheduled for October and December 1961 and February 1962.

Monthly Progress — VELA HOTEL

Program Administration

- On 1 April, following review and coordination by the Joint Planning Team and Hq Space Systems Division the VELA HOTEL Development and Funding Plan was forwarded to Hq Air Force Systems Command and ARPA for approval.

SPACE

defense programs

SAINT
ORBITAL INTERCEPTOR

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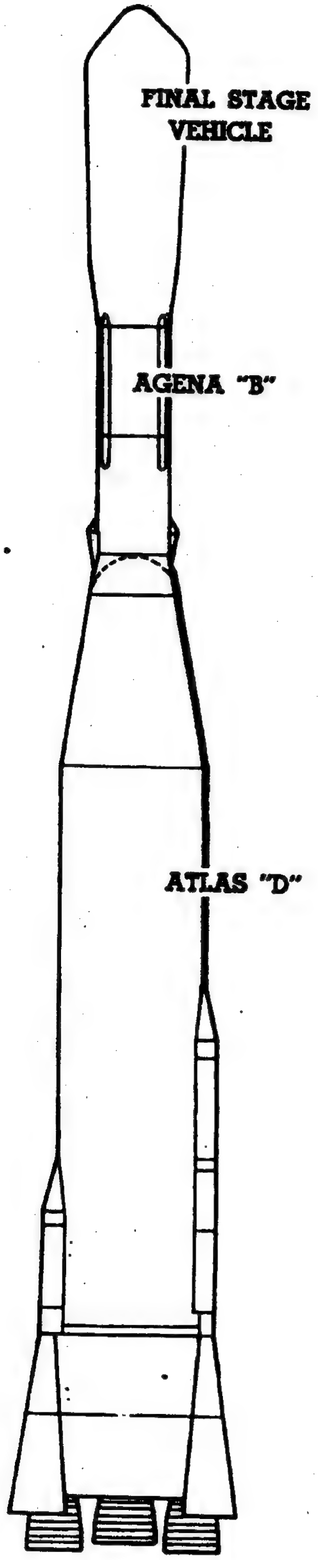
SAINT



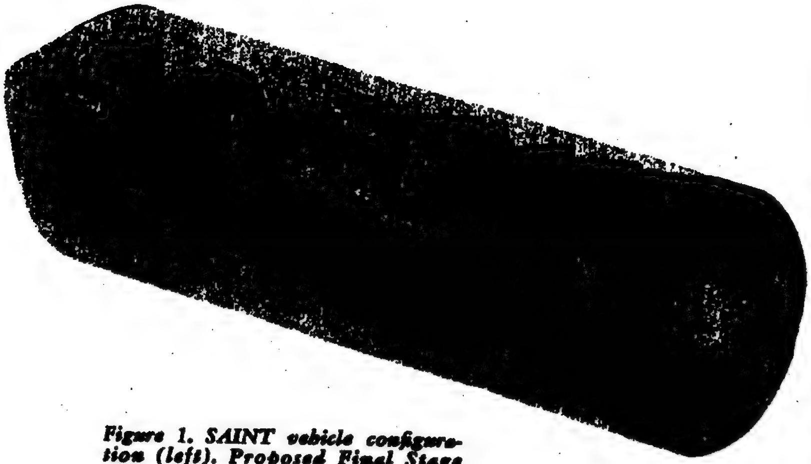


Figure 1. SAINT vehicle configuration (left). Proposed Final Stage Vehicle (above) showing search radar, velocity correction engine nozzle, control-gas storage spheres, and attitude control jets.

The SAINT (Satellite Inspector System for Space Defense) Program has been established to develop and demonstrate feasibility of a co-orbital satellite inspector system capable of rendezvousing with and inspecting suspected hostile satellites and assessing their mission.

Program Objectives

1. Design, fabricate, and demonstrate feasibility of a prototype vehicle capable of co-orbital rendezvous with another satellite at 400 nautical miles with a capability of inspecting and identifying the unknown satellite.

2. Study and define a SAINT vehicle which could be used as an ultimate defense vehicle having a capability of rendezvous up to 1,000 nautical miles with necessary orbit changes.

3. Develop and fabricate those long lead type items required for the ultimate defense system including a capability of negating hostile systems.

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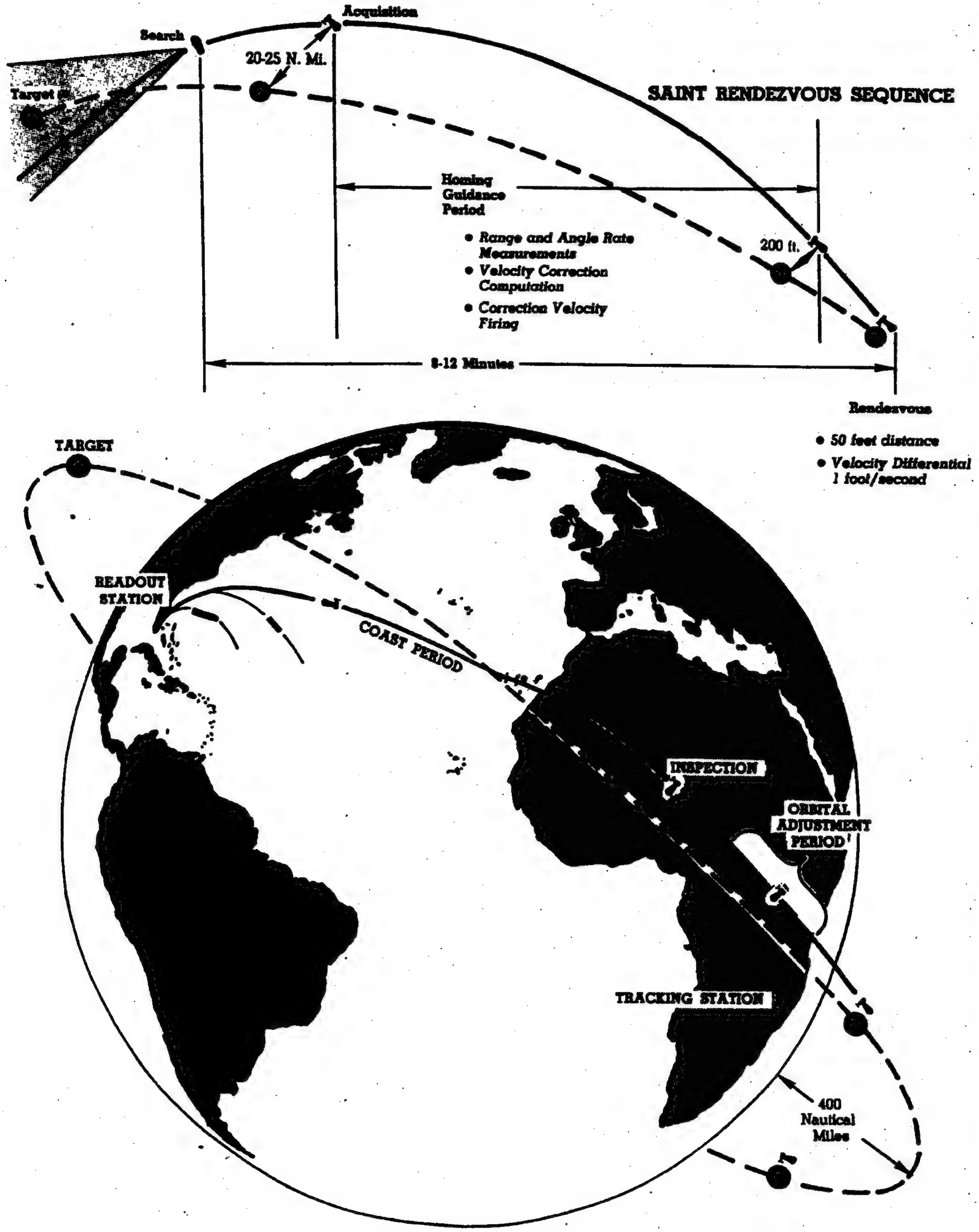
Acquisition
Search
20-25 N. Mi.
Target
SAINT RENDEZVOUS SEQUENCE
Homing Guidance Period
• Range and Angle Rate Measurements
• Velocity Correction Computation
• Correction Velocity Firing
200 ft.
8-12 Minutes
Rendezvous
• 50 feet distance
• Velocity Differential 1 foot/second
TARGET
READOUT STATION
COAST PERIOD
INSPECTION
ORBITAL ADJUSTMENT PERIOD
TRACKING STATION
400 Nautical Miles

Figure 2. SAINT Program feasibility demonstration flight and rendezvous sequence.

Program History

Initial satellite interceptor system studies were conducted by industry in 1958 under SR187. Studies were continued in 1959 by the Radio Corporation of America under ARPA contract and Space Technology Laboratories under AFBMD management. The STL study was completed 21 December 1959 and the RCA study 31 January 1960, both indicating SAINT would be a feasible system of practical value to the Department of Defense. Subsequently, the following actions have been taken:

1. AF System Development Requirement No. 18 published ....21 April 1960
2. AFBMC approval of SAINT Development Plan ....15 July 1960
3. Department of Defense approval of Development Plan ....25 August 1960
4. Air Force Development Directive No. 412 ....17 October 1960
5. Assigned Systems No. 621A. .31 October 1960
6. RCA chosen as Final Stage Vehicle and payload contractor....25 November 1960
7. Contract agreement with RCA 27 January 1961
8. Contract with RCA...........17 March 1961

Concept

Philosophy — The philosophy for development of the prototype vehicle calls for a step-by-step development program with a conservative choice of subsystems and emphasis upon reliability. Ground tests will provide assurance of component capability and reliability before flight.

Over-all System — Unidentified orbiting objects will be acquired, catalogued, and the ephemeris accurately determined through the facilities of the National Space Surveillance Control Center (NSSCC) utilizing available acquisition and tracking equipments. (It is anticipated that, for the ultimate operational system, the capabilities of NSSCC will be expanded to provide additional information such as target size, configuration and stability in orbit, possibly within 12 hours after detection.) This information will be relayed to a Defense Command Control Center which will determine if inspection is necessary. Should inspection be deemed necessary, the ephemeris information will be used to compute data which will be inserted into the guidance system of a SAINT vehicle. The vehicle will be launched into an appropriate position at a time which enables the final stage vehicle to go into orbit with the unknown satellite and inspect it at close range. This inspection data will be stored in the payload for transmission upon command to ground stations. After reception by the ground stations the data will be processed, displayed and evaluated, to determine the mission and intent of the unknown satellite.

Vehicle — The SAINT system as presently envisioned, consists of three stages including an active "Final Stage" or rendezvous vehicle. Early configurations of the SAINT vehicle will consist of a Series "D" ATLAS booster, AGENA "B" second stage, and a SAINT final stage vehicle. This configuration is shown in Figure 1. Later final stage vehicles having increased maneuvering capability and additional sensors would be boosted with the ATLAS/CENTAUR. The final stage vehicle (Figure 1) will include a radar seeker, launch and homing guidance system, attitude control, maneuvering propulsion and a payload. The payload will include a camera and various other sensors to determine the nature of the target satellite and its functional purpose. In addition the payload will have a storage and communications capability.

Feasibility Demonstration — Four flights launched from the Atlantic Missile Range, are planned for the feasibility demonstration. The first flight is scheduled in March 1963 with the subsequent flights scheduled at three month intervals. The feasibility demonstration configuration of the SAINT vehicle will consist of a Series "D" ATLAS booster, AGENA "B" second stage and a SAINT final stage vehicle. The demonstration final stage vehicle weighs approximately 2,400 pounds. In this demonstration (Figure 2), the final stage vehicle will be programmed to rendezvous with an existing satellite if one is available in a three hundred to five hundred mile easterly orbit. If such a satellite is not available, a target satellite will be placed in a 400 nautical mile, 28.8 degree inclination circular orbit by a 609A system booster. Rendezvous will be accomplished while under surveillance of a Southeast Africa station and a TV image of the target, in addition to the telemetered data of final stage vehicle performance, will be transmitted to the ground station. The image and data will also be stored and read out on command as the vehicle passes over the Air Force Missile Test Center. For the purpose of the feasibility demonstration rendezvous is defined as a closing of the final stage vehicle with the target satellite to within 50 feet and a relative velocity of less than one-foot per second. Station keeping will be maintained for one orbital period.

Future Development — Continued study toward definition of an ultimate operational system is being pursued simultaneously with the other phases of the program. This effort will distinguish certain long lead type items on which development action must be initiated and provide further refinements to the system. Included are extension of the maneuvering capability of the vehicle into 1,000 nautical mile orbits with the necessary station keeping and inspections of multiple targets as well as more exotic sensor capability. For example, a sensor capable of detecting a nuclear warhead is most desirable. Effort is currently underway to proceed with the development of such a sensor.

Program Management

AFBMD management of this program is based upon the associate contractor structure composed of a First Stage contractor, Second Stage contractor, Final Stage Vehicle contractor, and Systems Engineering and Technical Supervision contractor (Aerospace Corporation). Military support is provided by the National Space Surveillance Control Center through the Air Force Command and Control Development Division, and by the 6594th and 6555th Missile Test Wings.

Facilities

The demonstration program will utilize existing launch, tracking and data reduction facilities insofar as possible. However, some additional ground support equipment will be required at the Air Force Missile Test Center and at the Southeast Africa tracking site.

Monthly Progress — SAINT Program

Program Administration

- The contract for the Final Stage Vehicle (FSV), including payload, was officially approved at the Air Force Logistics Command, on 17 March. The contract is definitive and based on a cost-plus incentive fee on both performance and total program cost.

- A draft of the SAINT Operational System Development Plan has been completed and forwarded to the Air Force Systems Command for information and planning purposes. A draft of the SAINT System Package Program, in accordance with AFR 375 series, has also been completed. This draft is presently being coordinated with affected agencies.

- Representatives from Aerospace Corporation, Radio Corporation of America, Convair Astronautics, Lockheed Missiles and Space Division and Space Systems Division attended the first Systems Engineering and Technical Direction (SETD) meeting on interfaces. The purpose of this meeting was to determine the configuration of the booster vehicles for the SAINT Program and define interfaces.

- The first Final Stage Vehicle SETD meeting was held in Burlington, Massachusetts, and was attended by Aerospace Corporation, Radio Corporation of America and Space Systems Division personnel. The purpose of the meeting was to review RCA's progress and organize the design approach to be used in the design of the Final Stage Vehicle.

- Contracts are in process with Convair-Astronautics and Lockheed Missiles and Space Division to conduct a study of Atlantic Missile Range Stand 13 requirements to accommodate both SAINT and ADVENT vehicles including ATLAS/AGENA and ATLAS/CENTAUR configurations.

- Representatives from Aerospace Corporation, Radio Corporation of America, 6555th Test Wing (Development), Air Force Missile Test Center and Space Systems Division met on 9 March, to review the SAINT Program requirements at the Atlantic Missile Range.

- Personnel from Aerospace Corporation and Space Systems Division attended the first report on the NASA Orbital Docking and Fuel Transfer Program presented by Space Technology Laboratories and Lockheed Missiles and Space Division. Space Systems Division is maintaining close liaison with NASA George C. Marshall Test Center Future Projects Office so that technical information which may be of interest to both SAINT Program and the Orbital Docking Program can be exchanged.

ORBITAL INTERCEPTOR

The Orbital Interceptor Program has been established to develop an operational, space based, anti-intercontinental ballistic missile defense system.

Program Objective

- The primary objective of the Orbital Interceptor Program is to develop a space based defense system which will detect, intercept, and destroy hostile intercontinental ballistic missiles during the powered phase of their trajectory. A second and equally important system objective is to develop the capability of detecting, intercepting, and destroying space vehicles launched from a hostile nation.

Program History

- In mid 1959, both the Air Force and ARPA, by independent studies, became aware of the potential of a space based system for ballistic missile defense. Convair, under an ARPA sponsored study, had developed a concept for a Space Patrol Active Defense (SPAD) system which showed considerable promise. An AFBMD study, directed by Headquarters ARDC, concluded that a space based system which intercepted ballistic missiles during the boost phase was extremely attractive. In January 1960, by agreement between the Office of the Secretary of the Air Force and the Director of Defense Research and Engineering, the Air Force and ARPA entered into a joint program whereby ARPA would retain responsibility for system study, and ARDC would supplement this work with applied research. AFBMD was designated as the agency to integrate both efforts and serve as executive project agent for both organizations. In February 1960, the Ramo-Wooldridge Corporation was placed on contract for a study of their Random Barrage System (RBS) which was another design approach to a boost phase AICBM system. At the conclusion of the SPAD and RBS studies in May 1960, both the Air Force and ARPA carried on an extensive evaluation of the results. At the direction of ARPA, an ARDC Technical Evaluation Board was convened at AFBMD to evaluate the technical validity, operational capability, and program feasibility of the system concept and to recommend a follow-on program. Other evaluations were carried on by ARPA, the Air Force Scientific Advisory Board, AFMDC, and The RAND Corporation. All agreed essentially that the concept was valid, that no acceptable system design was yet in evidence, that more detailed design studies were required, and that an extensive applied research effort must be undertaken to collect the data required for design implementation.

Program Concept

- The Orbital Interceptor system will consist of a large number of space based interceptors deployed at random along inclined orbits which are distributed so that defense coverage of hostile nation areas of interest is provided. The altitude of the orbital interceptors will be approximately 200 nautical miles. Each of the satellite/interceptors will be independent, automatic, and self contained. They will not have communication with each other but will have contact with the ground based defense network when they pass over a secure communications "fence" in mid-United States. Under normal circumstances, each satellite will have a pre-set program which will cause it to search for targets only over hostile territory. By employing an infrared search set, the satellite will detect an ICBM as it emerges from the atmosphere. Upon determination that this target is within its area of kill, an interceptor containing an infrared seeker will be launched to home in on the target. Upon approaching the ICBM, the interceptor will deploy a large number of light weight pellets designed to strike the missile booster while it is still burning. The combination of orbital velocity and interceptor incremental velocity provide the pellets with extremely high energy. This energy is sufficient to cause major damage to the booster motor, thereby destroying the ICBM or causing the warhead to fall as much as 1,000 miles short of its target.

- The size of the orbital interceptors is such that a fairly large number can be deployed into orbit simultaneously from one booster. A booster such as the ATLAS/CENTAUR could be used as an interim booster for research and development test and initial operational deployment of the system. Economic feasibility of the system, however, is dependent upon the development of a large low cost booster, such as the PHOENIX, since 50 to 70 percent of the system cost is that of deploying payload in orbit.

- As in any defense system, the Orbital Interceptor system can be saturated. A hostile nation could reduce the effectiveness of the system by concentrating his launch sites in a given area and launching his missiles in a salvo of less than one minute. The possibility of a nation resorting to this strategy is difficult to evaluate. The system does possess, however, very attractive characteristics which enable it to be extremely effective against dispersed launches and against missiles with long burning times. These characteristics enable the system to be particularly suited to defense against mobile ICBM launches, space launches, attacks from minor missile powers, accidental launches both friendly and hostile, and against sustained ICBM launches after the first onslaught of a general war. The number of orbital interceptors required for these missions is considerably less than that required for compact salvos.

Program Status

- The current Orbital Interceptor FY 61 program consists of four parts: system design studies; support system studies; Orbital Interceptor oriented applied research studies; and test vehicles (R&D test program).

- ARPA has directed AFBMD to undertake three or more competitively selected system design studies. The objectives of each of these studies are: to perform detailed design studies of the satellite, interceptor and deployment package; to analyze the design requirements for the support systems; and to analyze the technical, economic, and operational feasibility of the system design. A second part of the study is to conduct detailed analyses, simulation, and experimental testing of the critical components and techniques which are essential to establishing technical validity of the design. An AFBMD/BMC Source Selection board convened on 13 February 1961 and reviewed the proposals submitted by the various bidders. On 15 March the board results were briefed to Hq ARDC and on 15-16 March ARPA was briefed. ARPA approval of the board's action, and an announcement of the three contractors to participate in its system design studies is expected early in April.

- A Development and Funding Plan is being prepared covering Command and Control Study, Reliability Evaluation, Ground Launch Complex Study, Payload Booster Study, Operations Analysis, and a Countermeasure Study. The first three efforts have been funded. The last three are not yet funded but a recommended reallocation of funds by task has been forwarded to ARPA. Approval of the Development and Funding Plan and the proposed reallocation of funds is expected in April 1961. However, these tasks will not be implemented until after the system design studies begin.

- AFBMD has been working with ARPA and the cognizant Divisions and Centers of ARDC to define a program of Orbital Interceptor oriented applied research which will provide essential data and techniques. Extensive and expanded effort is required in: infrared target radiation, background, and blackout measurements; hypervelocity kill mechanisms; hypervelocity interceptor guidance and control techniques; interceptor propulsion; countermeasures and infrared equipment techniques. A substantial program of kill mechanisms has been approved by ARPA. As other programs are defined and prepared, they will be submitted to ARPA. It is essential that these applied research programs be initiated as soon as possible so that the data collected can be integrated into the system feasibility studies.

Management

- In October 1960, a decision was reached that ARPA would retain program responsibility and fund the major part of the program in FY 61. AFBMD was retained as the executive project agency to integrate the system and applied research parts of the program.

- All the work under the present phase of the Orbital Interceptor program, whether it be on contract with industry or placed through another ARDC organization, is under the technical management and direction of AFBMD. The Aerospace Corporation is assisting AFBMD by providing system analysis, technical analysis, and evaluation services. Under present plans, this phase of the program will provide data by January 1962, from which an evaluation can be made as to the technical, economic, and operational feasibility of the Orbital Interceptor system. If feasible, it is planned to initiate development of the system and its support systems by April 1962. By this time, program responsibility will transfer from ARPA to the USAF.

Ground Facilities

- The large number of satellites required for full operational deployment of the system will demand production type launches from facilities located at both the Atlantic Missile Range and Vandenberg Air Force Base. The frequency of launch will require new facilities at each location.

- A major element of the system is the ground based command and control complex. This complex will provide the facilities for secure communications with the satellites so as to transmit necessary programming instructions, and to receive information on operational status. This complex will also provide ground links with the Air Defense Commander and the National Space Surveillance Control Center. Wherever possible, existing facilities will be utilized. However, there will be command and control requirements peculiar to the Orbital Interceptor system which must be designed and procured as a separate support system.

Monthly Progress — ORBITAL INTERCEPTOR

Program Administration

- Representatives from the Air Proving Ground Center briefed Space Systems Division and Aerospace Corporation personnel on 7 March regarding facilities and technical support which could be made available to a proposed space probe infrared target radiation program. This program is under study as a means of providing infrared measurements from space on the ballistic missile launched from the Atlantic Missile Range. Although this program is primarily for BAMBI requirements, it will also provide valuable information for MIDAS.

- A meeting was held at Aeronautical Systems Division (ASD) on 8-9 March to define administrative and technical support to be provided by ASD for the Space Systems Division KC-135 RAMP (Radiation Measurements Program) aircraft. Space Systems Division representatives briefed the Air Force Systems Command on 10 March on the suggested support and technical responsibilities of each of the Project RAMP participants (SSD, AFMTC, and ASD).

- On 15-16 March the Air Force Systems Command and ARPA were briefed on the results and recommendations on the BAMBI/ORBITAL INTERCEPTOR Source Selection and Technical Evaluation Boards. These boards met on 13 and 17 February, respectively, to review the proposals received from industry to perform Phase II System Design Feasibility Studies. Space Systems Division is awaiting ARPA's decision regarding implementation of the BAMBI/ORBITAL INTERCEPTOR Phase II effort. On 28 March, Dr. Charyk, Undersecretary of the Air Force and Dr. Ruina, Director of ARPA, were briefed on the proposed Phase II program.

BIOASTRONAUTICS

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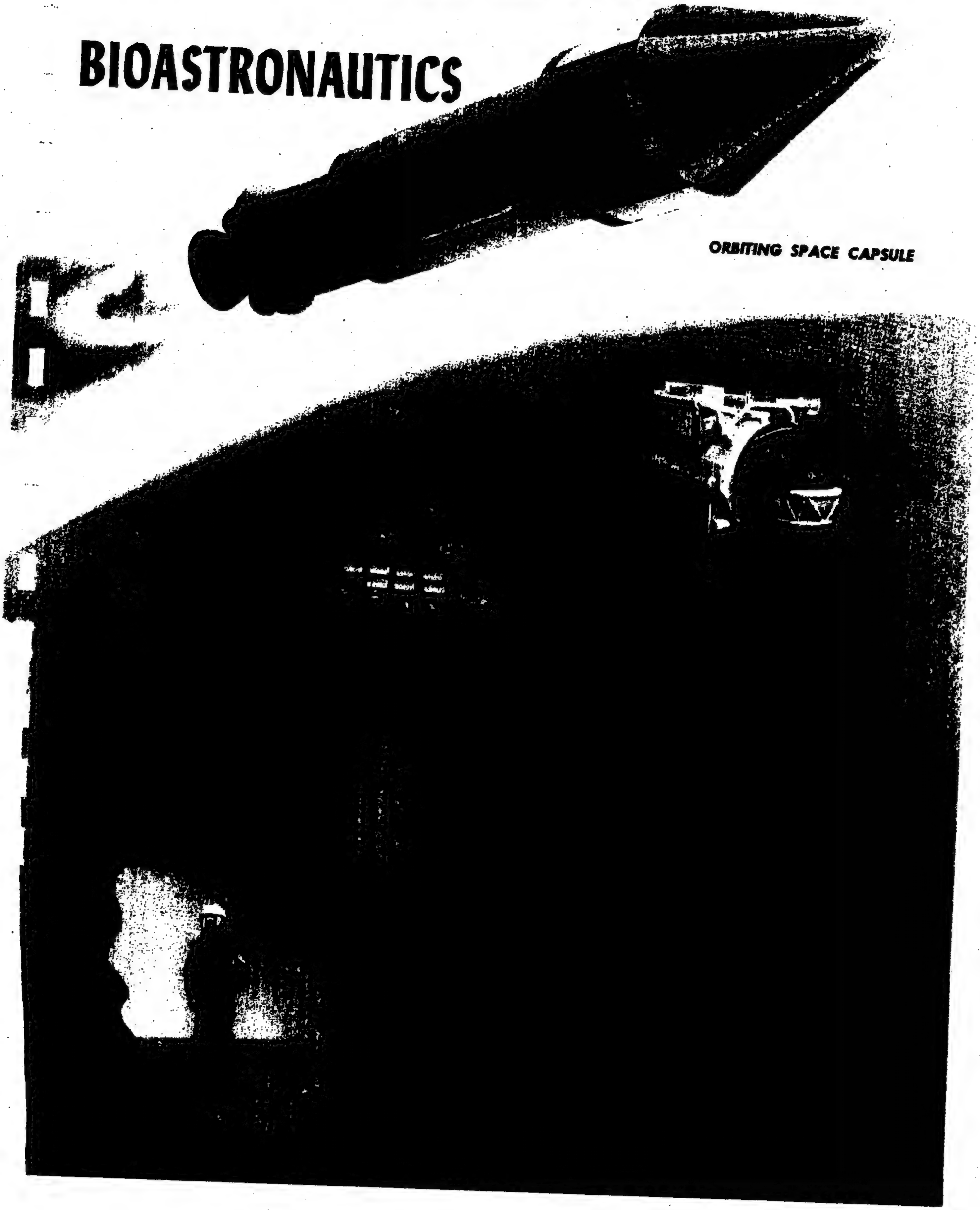
BIOASTRONAUTICS



ORBITING SPACE CAPSULE

Wilcox
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Program History

The BIOASTRONAUTICS Office was established in May 1958 and charged with the biotechnical supervision of the early military "Man-in-Space" Program and the Bioastronautics aspects of the DISCOVERER Program. NASA was subsequently assigned the "Man-in-Space" responsibility in the fall of 1958. The development and fabrication of suitable Biomedical Recovery Capsules for the DISCOVERER Program has continued without interruption.

On 13 May 1959, a MARK I biomedical capsule was successfully flown without specimens. The flight telemetry demonstrated successful operation of the Bioastronautic subsystem as an engineering concept. Although re-entry was successful, recovery was not accomplished. A second MARK I capsule was launched on DISCOVERER IV on 25 June 1959 with four mice aboard. Although orbit and recovery were not achieved, 600 seconds to telemetry showed the animals to be in good condition throughout the flight.

Subsequent DISCOVERER efforts culminated in preparation of a MARK II capsule suitable for a small primate. Launch and recovery of a small primate from orbit awaits approval of an "Abbreviated Space Systems Development Plan, Biomedical Program" submitted to Hq AFSC in November 1960.

Applied Research contracts for the design and development of advanced biocapsule hardware include photosynthetic oxygen production, super-critical gas storage, radiation shielding and bio-instrumentation. All components are scheduled to be flown in subsequent advanced space biocapsule programs.

An Advanced Biomedical Capsule has successfully completed the mockup phase of development. The capsule is designed to carry a fifty pound chimpanzee to altitudes of about 25,000 n.m. to thoroughly explore and assess the radiation hazards of the inner and outer Van Allen Belts. In addition, long-term weightlessness effects will be investigated. On 7 November 1960, Space Systems Division approved continued development of the advanced capsule in support of eventual manned military space systems.

Program Concept

The complete exploration of space, including limits to manned operational space systems, requires a determination of the biological effects of the space environment. The Space Systems Division is continuing its aggressive research and development program in this technical area to insure that sufficient bioastronautics knowledge will be available during the 1963-1965 time period. Present deficiencies in reaching these goals are: capsule development, life support system design, biological instrumentation and determination of space flight stresses (long term weightlessness, operational experience in the radiation belts, and isolation). Neither Project MERCURY with its short duration, low altitude orbit, nor DYNA SOAR with its low altitude suborbital flight will provide data concerning the key problems of long term weightlessness and Van Allen Belt radiation, Knowledge which is crucial to manned operational space systems.

The current BIOASTRONAUTICS Program is furnishing a limited amount of data from actual ballistic and orbital flights. Experiments include those made on a space-available basis aboard scheduled ICBM and DISCOVERER Program flights. The Bioastronautics Orbital Space System (BOSS), when approved as an Air Force system, will not be limited by piggy-back or space-available restrictions. Data obtained from these tests will be available for correlation with those obtained from laboratory experiments. The results will be of supplemental significance to the DYNA SOAR Program and Project MERCURY and will be necessary to the success of future manned military missions such as SMART.

Monthly Progress — BIOASTRONAUTICS Program

Supercritical Gas Storage

- The environmental control of a manned compartment of a space vehicle involves the supply of atmospheric constituents for breathing and compartment pressurization. A number of studies have shown that equipment for the storage of atmospheric constituents (oxygen, nitrogen and air) can require a significant portion of a space capsule's weight and volume, particularly for flights of extended duration. The development of reliable, compact, lightweight atmospheric fluid storage equipment suitable for zero gravity operation is, therefore, extremely important.

- Storage methods investigated for such applications include the use of high pressure gas containers, cryogenic storage tanks, oxygen generating chemicals and closed ecological systems. Studies of the state-of-the-art of each of these storage methods indicate that major emphasis should be placed on cryogenic storage for future applications.

- Extensive experience with manned aircraft has shown that cryogenic storage offers several important advantages over high pressure, ambient temperature storage of low boiling fluids such as oxygen and nitrogen. These advantages include:

1. Increased fluid carrying capacity for a given vessel size, resulting from the higher fluid density at cryogenic temperatures.
2. Reduced container weight for a given stored mass.
3. Provisions of potential refrigeration and cooling sources which can be of definite advantage in a closed cabin.

- The most promising technique (supercritical storage) consists of carrying oxygen as a cryogenic fluid at pressures between 1,000 and 1,500 psi. At this pressure level, which is higher than the critical pressure (736 psi) for oxygen the fluid consists of a single phase so that problems of phase separation are avoided. In addition, single phase storage promises to yield a system insensitive to gravity.

- The present study has emphasized optimization of thermal components for the prototype development and will test the supercritical oxygen system under zero gravity conditions. Flight test evaluation in an ATLAS "E"-pod will determine the feasibility of the supercritical cryogenic system. Nitrogen will be used as a working fluid.

Gravity Independent Photo Synthetic Gas Exchanger (GIPSE)

- This equipment is another approach to the problem of providing atmospheric constituents for life support in space capsules. This system has been developed to investigate the feasibility of gravity independent operation in the weightless space environment. The system uses a thermophilic strain of algae which converts carbon dioxide by the photosynthetic process to produce oxygen. Data obtained from the forthcoming flight in an ATLAS E-pod will determine the feasibility of this system when exposed to zero gravity conditions.

BIOASTRONAUTIC ATLAS Passenger Pod #1

- This pod, attached to the side of an ATLAS E ballistic missile, will carry five bioastronautic experiments. These include the (1) supercritical cryogenic storage system, (2) the GIPSE, (3) zero gravity potassium superoxide gas diffusion experiment and (4) two tissue equivalent radiation experiments. The supercritical cryogenic storage system is proceeding on schedule at the Air Research facility. The GIPSE flight item has been inspected at Martin-Denver and will be readied for the flight. Assembly and checkout of the pod is on schedule and the planned shipping date will be met. The launch is scheduled for mid-April.

Figure 1. The pod (left) will be attached to an ATLAS-"E" ICBM. The upper cylinder, which is covered with aluminum foil, will contain the Martin Gravity Independent Photo Synthetic Gas Exchanger. The AiResearch Supercritical Cryogenic Storage System is mounted on the lower shelf of the pod. Closeup (below) of the Supercritical Cryogenic Storage System showing the storage tank, plumbing, and electronic assemblies. This equipment is scheduled to be flown in mid-April.

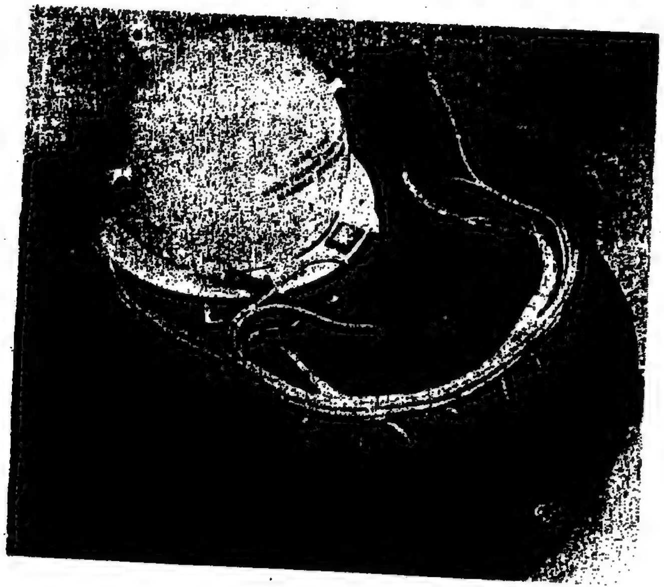
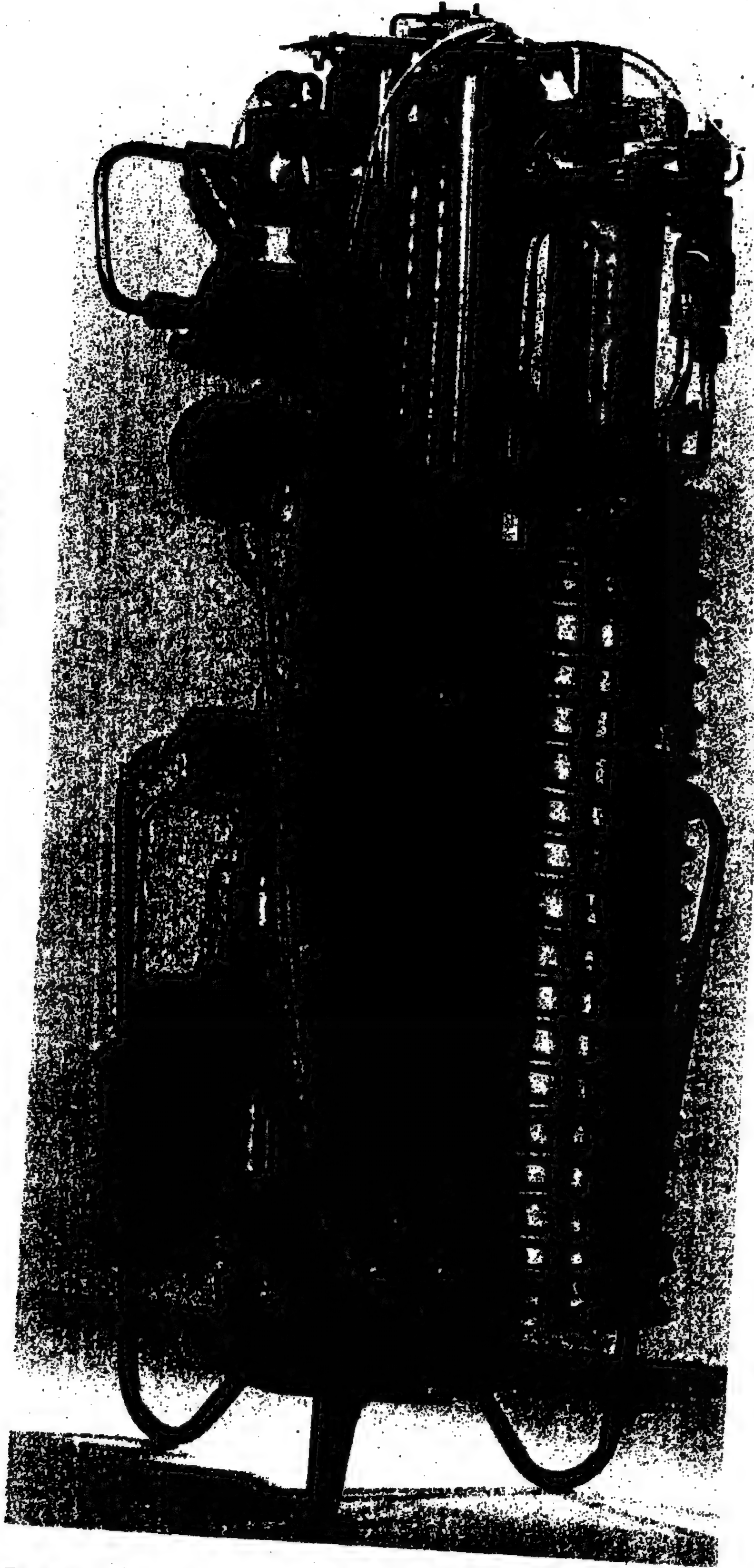


Figure 2. Closeup of the Gravity Independent Photo Synthetic Gas Exchanger. Conversion of carbon dioxide to oxygen takes place in a continuously circulating liquid. Plant nutrients in the temperature controlled solution are exposed to the proper light intensity. The oxygen produced in solution diffuses through a semi-permeable silicone rubber membrane and is then conducted to its ultimate use. This particular system produces approximately 90 cubic inches of oxygen in 24 hours. The algae which converts carbon dioxide to oxygen by the photo synthetic process is circulated through the center cylinder by the pump on the lower left of the equipment. The temperature of the liquid is controlled by passing it through the heat exchanger (the large cylinder on the right). The silicone tube, through which the oxygen diffuses, is visible inside the center cylinder.



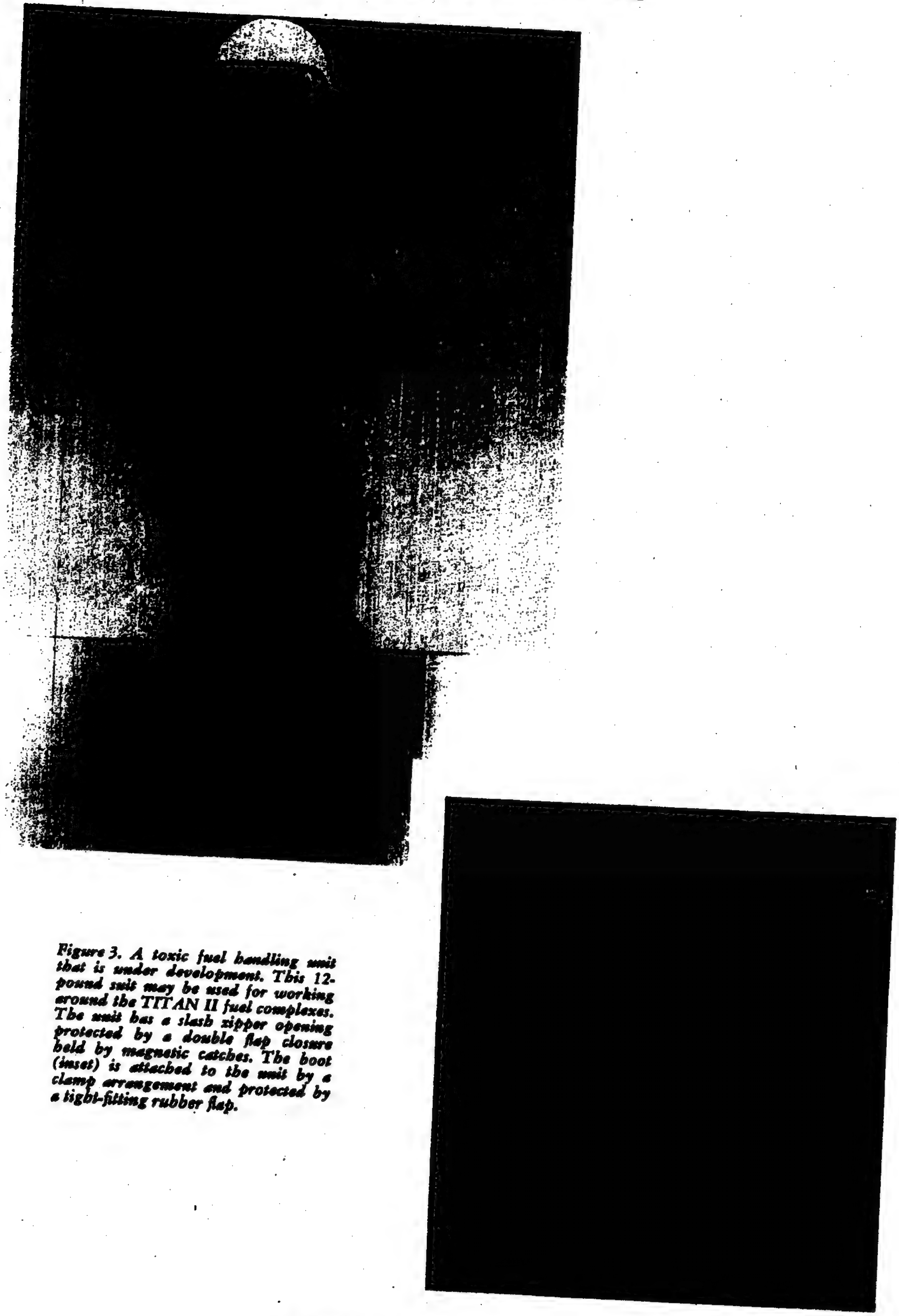


Figure 3. A toxic fuel handling unit that is under development. This 12-pound suit may be used for working around the TITAN II fuel complexes. The unit has a slash zipper opening protected by a double flap closure held by magnetic catches. The boot (inset) is attached to the unit by a clamp arrangement and protected by a tight-fitting rubber flap.

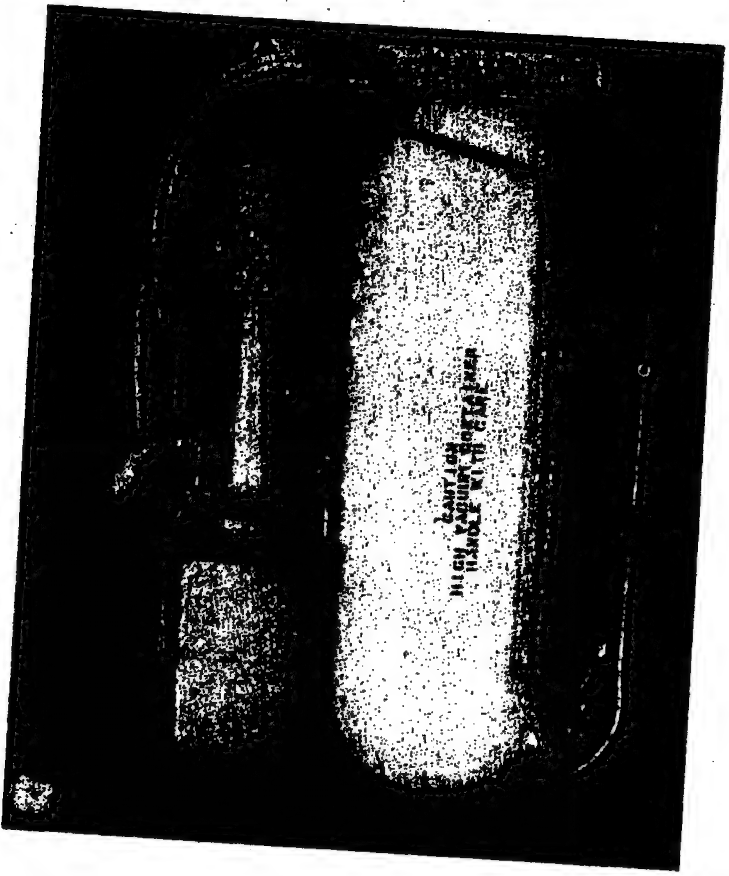
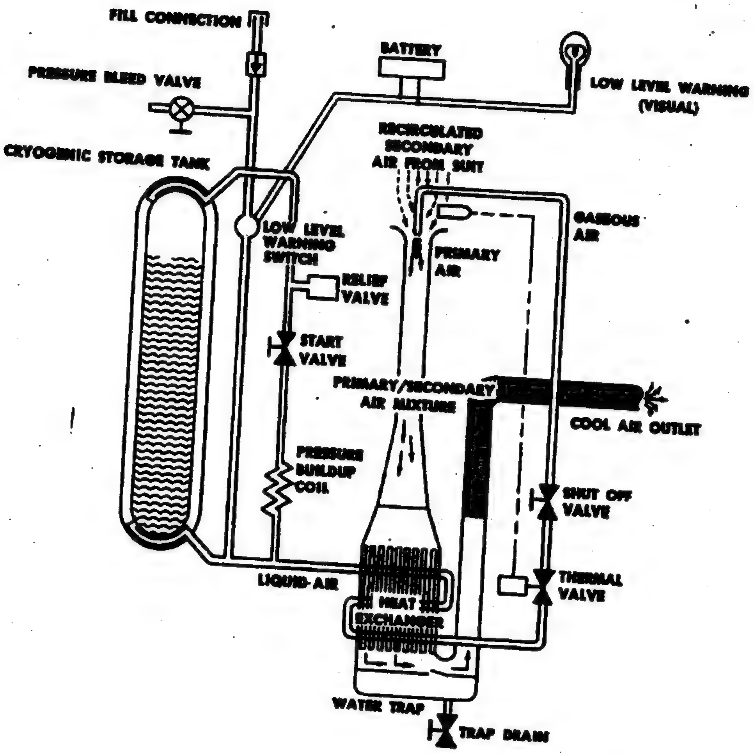
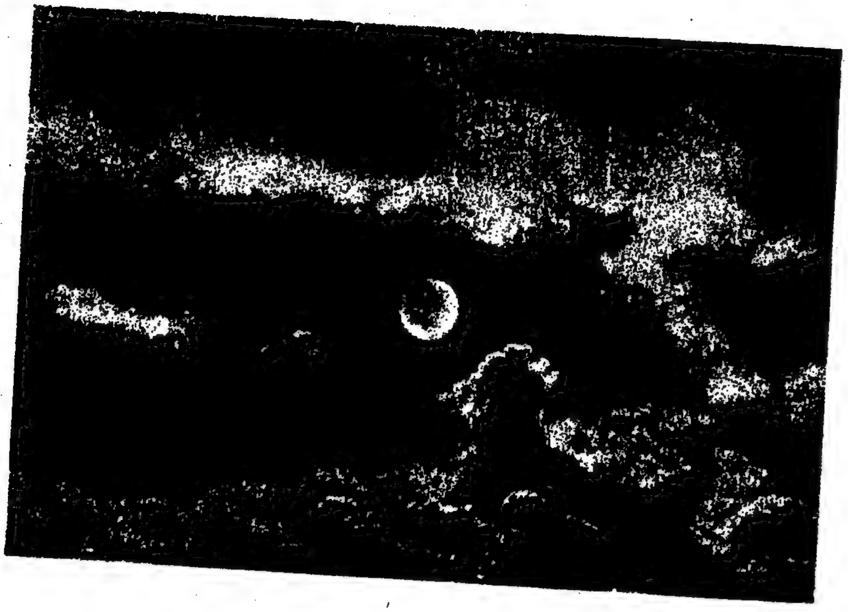


Figure 4. The AiResearch Life Support System which is used with the fuel handling suit shown on the opposite page. This unit, which weighs 21 pounds, is capable of maintaining 74°F inside the suit in ambient temperatures ranging between −20°F and +120°F. The unit circulates approximately 10 cu. ft. of air per minute and provides environmental protection for over one hour. No external power is required and it contains no moving parts. The diagram below shows the major units composing the life support system and shows how the system works.



SPACE

program boosters



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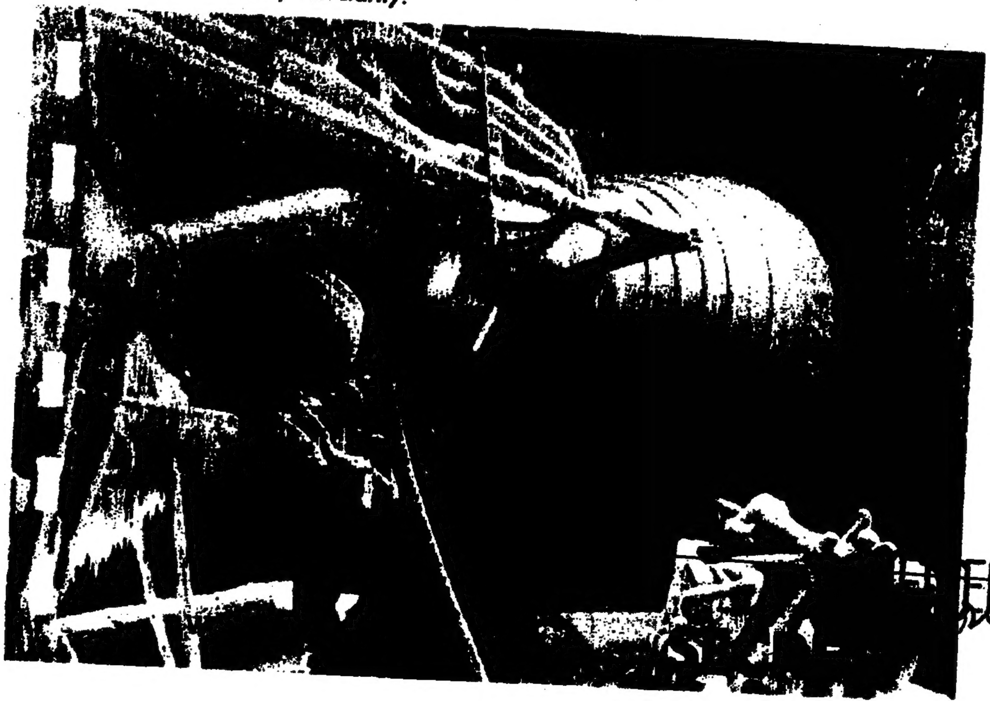
BOOSTERS

- The primary pacing factor in the accomplishment of space missions has been, and for some time will continue to be, the availability of Air Force ballistic missiles and upper stages to boost the payload vehicle. Space flight planning requires close examination of all technological areas wherein advances provide increases in booster and mission capability. This, in turn, has required that space schedules be sufficiently flexible to incorporate rapidly those advances in the state-of-the-art which increase the potential for reliable and predictable space research.

- Because of the wide range of its activities, AFBMD has accumulated a broad base of experience in booster selection for space missions Experience in ballistic missile R&D programs and in development of upper stage vehicles have provided much information. Research programs in the propellant and materials areas also are providing new capability for space research. The number and variety of boosters available permit the selection of a combination of stages tailored to provide specific capabilities for specific missions.

- The following pages describe briefly the booster vehicles currently being used by AFBMD to support military and civilian space programs. Nominal performance data is given to permit nominal comparisons of vehicle capabilities. Specific qualifications are made where necessary for clarity.



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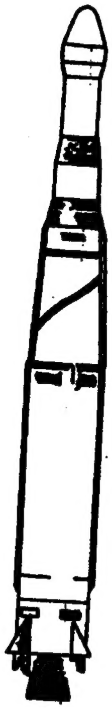
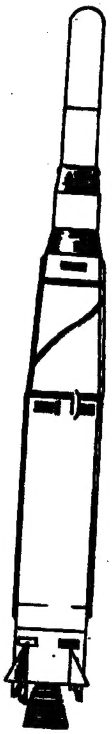
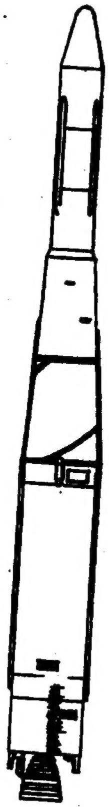


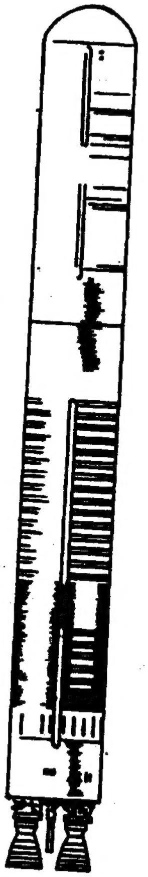
DM-21/Ablestar



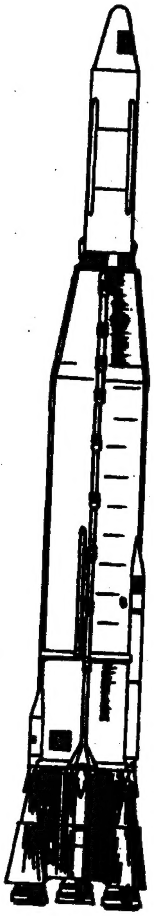
DM-21/Ablestar/ 30 KS 8000



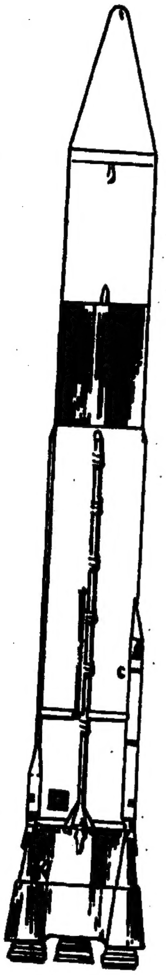
DM-21/AGENA B



TITAN II



ATLAS D/AGENA B



ATLAS D/CENTAUR

Program Vehicle Combinations

ABLE—1,—3 and —4	A	[illegible]	F
ABLE—4 and —5	D	[illegible]	[illegible]
ADVENT (Phase One)		D	H
ADVENT (Phases Two and Three)	D	N	
COURIER	C	M	
DISCOVERER (1 thru 15)	A	[illegible]	
DISCOVERER (16 thru 19)	A	H	
DISCOVERER (20 and subs)	E	I	
DYNA SOAR	E	[illegible]	
MERCURY		D	
MIDAS (I and II)	D	G	
MIDAS (III and subs)	D	[illegible]	
NASA AGENA "B"	E	I	
ORBITAL INTERCEPTOR	D	N	
SAINT	D	H	
TIROS	A	[illegible]	[illegible]
TRANSIT 1A	A	[illegible]	[illegible]
TRANSIT 1B thru 5B	C	M	
VELA HOTEL	E	M	Q

NOTE: Light type indicates completed programs   Bold type indicates active programs

Specifications

BOOSTERS

THOR — Douglas Aircraft Company

	A DM-18	B DM-21	C DM-21A
Weight — dry			
Fuel — RP-1	6,727	6,590	6,950
Oxidizer — Liquid Oxygen	33,500	33,500	33,500
Total	68,000	68,000	68,000
Height — feet	108,227	108,090	108,450
Engine — Rocketdyne Division of North American Aviation	61.3	55.9	60.5
Thrust — lbs. (sea level)	MB-3 Block I	MB 3 Block II	MB 3 Block I
Spec. Impulse — lb.-sec/lb. (sea level)	152,000	167,000	152,000
Burn Time — seconds	247.0	248	247
Guidance — Bell Telephone Laboratories series 400 or autopilot only.	163	152	163
	㉛ 35 89	⑦ 7 100	④ 6 66

ATLAS — Convair-Astronautics

	D Series D
Weight — wet	
Fuel — RP-1	
Oxidizer — Liquid Oxygen	15,100
Total	74,900
Height — feet	172,300
Engine — Rocketdyne Division of North American Aviation	262,300
Thrust — lbs. (sea level)	69
Booster	MA-5
Sustainer	
Specific Impulse — lb-sec/lb. (sea level)	356,000
Booster	82,100
Sustainer	
Guidance — Radio-inertial Mod II/III — General Electric (radar), Burroughs (computer)	286 310
	⑨ 11 82

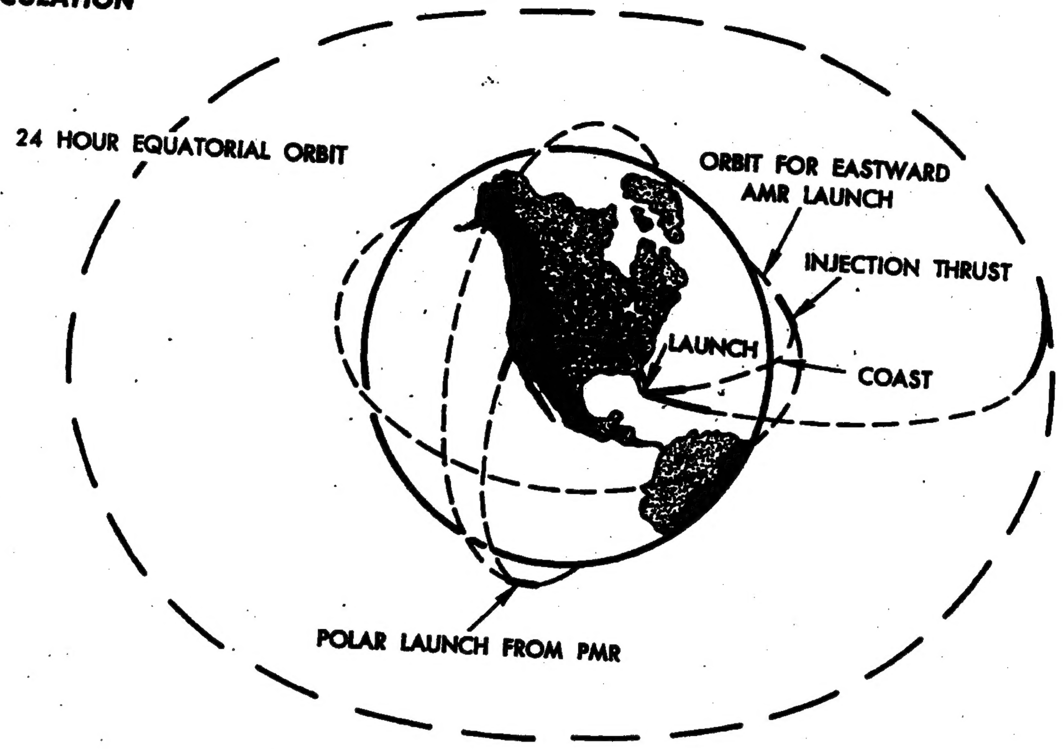
TITAN II — The Martin Company

	E FIRST STAGE		F SECOND STAGE
Weight — dry			
Fuel — N_2H_4/UDMH	9,821		5,469
Oxidizer — N_2O_4	84,046		20,200
Total	162,800		37,702
Height — feet (combined first and second stage)	256,667		63,371
Engine — Aerojet-General Corporation		89.38	
Thrust — lbs. (sea level)	XLR87AJ-5		XLR91AJ-5
Specific Impulse — lb-sec/lb. (sea level)	430,000	(vacuum)	100,000
Burn Time — seconds	260		315
Guidance — ACSP all inertial in second stage	149.3	(vacuum)	182.4

UPPER STAGES

	P ABL X248-9 Allegany Ballistics Laboratory	Q 30 KS-8000 Aerojet-General Corporation
Weight — wet		
Propellant — Solid	60	100
Total	459	870
Height — feet	519	970
Engine		6.5
Thrust — lbs. (vacuum)		
Specific Impulse — lb-sec/lb. (vacuum)	2,750	7,985
Burn Time — seconds	254 42.1	274
	⑧ 10 80	

LAUNCH CAPABILITIES CALCULATION



Performance Summary—EXISTING OR PROGRAMMED BOOSTERS